PD-ABZ-295

End of Project Report

Geographic Information for Sustainable Development—GISD
October 1, 2001 to June 30, 2003

Funded by

USAID Grant Number: ECG-G-00-01-00010-00

Submitted to

The United States Agency for International Development

by

IFDC—An International Center for Soil Fertility and Agricultural Development

January 2004

Geographic Information for Sustainable Development—GISD

General Overview

IFDC served as Secretariat for the USAID-funded project on "Geographic Information for Sustainable Agriculture (GISD). Within this project, 14 separate sub-projects were conducted in sub-Sarahan Africa each using geographic information technologies (Remote Sensing, Global Positioning Systems [GPS], Geographic Information Systems [GIS] and Database Management) to inventory natural resources and formulate strategies for sustainable development.

IFDC's role as Secretariat of the GISD Project was to facilitate the funding of the projects through development of MOUs with the collaborators and to facilitate the participation (logistics and travel arrangements) of African partners in project workshops in Bamako, Asmara, Nairobi, London, the World Summit on Sustainable Development (WSSD) in Johannesburg, and the AAAS Conference Denver and Washington, D.C.

Introduction

On Friday, September 28, 2001, the PIO (Public International Organization) grant with IFDC (International Fertilizer Development Center) was signed by USAID appointing IFDC to provide support for the Geographic Information for Sustainable Development (GISD) project leading up to the World Summit on Sustainable Development (WSSD). The effective date of the contract was October 1, 2001. IFDC received the contract on October 15, 2001. All coordination from USAID was provided by:

Mr. Bob Ford (USAID)
Natural Resource Planner & Policy Advisor,
USAID, G/EGAD/AFS - Office of Agriculture & Food Security,
Co-Manager RAISE IQC
Ronald Reagan Bldg., Rm 2.11-054
Washington, D.C. 20523-2110

Specifically, IFDC had the following responsibilities:

1. Transfer and provide overall fiscal oversight to "pass-through" funds to GISD partners.
2. Provide basic assistance in making travel and other logistical arrangements for participants to attend planned meetings.
3. Setup a secretariat—to be the central contact point—for handling communications and group interactions necessary to facilitate the yearlong effort (e-mail list, phone contacts, etc).
4. Cooperate with partners for publication of materials, case studies, and lessons learned that come out of the activity.

Section 1: Pass-Through Funding to GISD Partners:

IFDC's primary responsibility in the GISD Project was to transfer funds to finance projects that were selected by USAID to fulfill the objectives of the project and to provide overall fiscal oversight to these "pass-through" funds to GISD partners. All of the participating research organizations were selected by USAID. Likewise, the Scope of Work for their research and the level of funding for these activities were negotiated directly between USAID and the partner research organization. The Scope of Work for each participating research organization was provided by USAID to IFDC and was incorporated as an integral part of each Memorandum of Understanding (MOU) developed with those organizations. The following summarizes the organizations and projects for which USAID directed IFDC to provide pass-through funding:

1. **Target Region 1 (Upper Niger Basin)**
   a. USGS-EDC & AGRYHMET/ FEWS.NET Project
   b. USGS-EDC & USAID/Mali with OHVN & Burkina Yatenga Scientists
   c. University of Georgia SANREM CRSP & IER/Mali

2. **Target Region 2 (African Great Lakes)**
   a. ICRAF-AFRENA-Africare & USAID/Uganda
   b. Texas A&M University GL CRSP – LEWS Project & RCMSR
   c. Louisiana State University – HealthWhere Module
   d. Mud Springs Geographers – HealthWhere Module

3. **Target Region 3 (Kenya-Tanzania CZM)**
   a. University of Rhode Island & Tanzania Coastal Mnt. Partnership – CRC

4. **Target Region 4 (Limpopo/Zambezi)**
   a. World Wildlife Fund
   b. USGS-EDC & World Wildlife Fund
   c. World Resources Institute

5. **Target Region 5 (Africa-Wide Capacity Building)**
   a. Open GIS Consortium
   b. National Academy of Sciences
   c. USGS-EDC & UNECA

6. **Association of American Geographers – MyCoe Project**
   As indicated above, IFDC was instructed by USAID, through this contract, to develop MOU's with each of the partner research organizations that would incorporate the Scope of Work and Funding decisions provided by USAID. The MOUs that were put into effect with each of the participating organizations are summarized below and are attached to this report in Annexes 1-12. Also included in Annexes 1-12 are the final reports provided by the collaborating organizations upon the conclusion of their GISD Project activities.

Section 2: Travel and logistical arrangements for participants to attend planned meetings:

One of IFDC's responsibilities while serving as Secretariat of the GISD project was to facilitate travel and other logistical arrangements for participants to attend planned meetings. Each of the meetings (including identification of invited participants, meeting agenda, dates, locations and budgets) was organized directly by USAID, whereupon IFDC was instructed to facilitate the attendance of the invited participants. IFDC's role included:

- Sending invitations to the invited participants.
- Communications with participants regarding attendance, purchase of airline tickets, lodging

arrangements, visas, etc.

- Reimbursement of travel expenses (airline tickets, lodging, per diem, etc.) incurred by the invited participants.

The meetings organized by USAID for which IFDC provided logistical support include:

- **Collaborators Workshop in Bamako, Mali**
  - March 13-15, 2002
  - 46 participants (11 funded by GISD Project)
- **Collaborators Workshop in Asmara, Eritrea**
  - April 3-7, 2002
  - 61 participants (17 funded by GISD Project)
- **Collaborators Workshop in Nairobi, Kenya**
  - April 9-10, 2002
- **AAAS Conference in Denver, Colorado**
  - February 2003
  - 5 African participants funded by GISD Project

Additionally, IFDC provided similar support to the Project participants that attended the **World Summit on Sustainable Development (WSSD) in Johannesburg, South Africa,** August 24-September 4, 2002

1. **GISD Partners Meeting in Bamako, Mali (March 13-15, 2002)**

   IFDC sent invitations to forty-six (46) participants. Fourteen (14) received invitations indicating that IFDC would reimburse some or all of their travel expenses, but six of those did not attend the meeting. Thirty-two (32) received invitations indicating that they would be responsible for their own travel expenses. Payment was processed for those being reimbursed by IFDC at USAID's request. A list of those receiving reimbursement is shown in Annex 12.

Additionally, Dr. Paul Wilkens represented IFDC at the Bamako meeting and presented a paper on "Linking Biophysical and Economic Models within a Spatial Framework."

2. **GISD Partners Meeting in Asmara, Eritrea (April 3-6, 2002)**

IFDC sent invitations to sixty-one (61) participants, including FAO participants. Seventeen (17) received invitations indicating that IFDC would reimburse some or all of their travel expenses, of which twelve (12) attended the meeting. Forty-four (44) received invitations indicating that they would be responsible for their own travel expenses. Payment was processed for those being reimbursed by IFDC at USAID's request. A list of those receiving reimbursement is shown in Annex 12.

Additionally, Dr. Paul Wilkens represented IFDC at the Asmara meeting and presented a paper on "Linking Biophysical and Economic Models within a Spatial Framework."

3. **GISD Partners Meeting in Nairobi, Kenya (April 9-10, 2002)**

IFDC reimbursed six (6) participants for airfare, lodging, and per diem attending the Nairobi, Kenya GISD partners meeting. Payment was processed for those being reimbursed by IFDC at USAID's request. A list of those receiving reimbursement is shown in Annex 12.

4. **GISD Partners Meeting in London, England (June 8-15, 2002)**

IFDC reimbursed five (5) participants for airfare, lodging, and per diem attending the London, England GISD partners meeting. Payment was processed for those being reimbursed by IFDC at USAID's request. A list of those receiving reimbursement is shown in Annex 12.

5. **GISD Partners Traveling to WSSD, Johannesburg (August 22–September 7, 2002)**

IFDC reimbursed seventeen (17) participants for airfare, lodging, and per diem attending the World Summit for Sustainable Development (WSSD). Payment was processed for those

being reimbursed by IFDC at USAID's request. A list of those receiving reimbursement is shown in Annex 12.

Additionally, IFDC was represented by Lawrence L. Hammond, Paul W. Wilkens, and Walter T. Bowen, who assisted in operating the GISD booth at the WSSD and providing local transportation and other logistical support to the GISD Project participants that attended the WSSD.

CDs containing all of the presentations by GISD participants at the meetings in Bamako, Asmara, and Nairobi were prepared by IFDC and distributed to all GISD partners.

6. **GISD Partners Traveling to the AAAS Conference, Denver, Colorado (February 10–21, 2003)**

IFDC reimbursed five (5) participants for airfare, lodging, and per diem attending the symposium, "Down to Earth: Geographic Information for Sustainable Development in Africa," during the 2003 American Association for the Advancement of Science (AAAS) Conference. Payment was processed for those being reimbursed by IFDC at USAID's request. A list of those receiving reimbursement is shown in Annex 12.

Additional Participant Travel

1. At USAID request, funding was arranged (US $1,500) for Vedast Max Makota, Dar-es-Salaam, Tanzania, for travel to attend the Africa-GIS Conference in Nairobi, Kenya during November 5-9, 2001.
2. At USAID request, funding was arranged (US $1,115) for Robin White, GIS expert at WRI, for travel to attend the LADA meeting in Rome on 21-27 Jan 2002. WRI paid for the airfare and the travel funds provided by IFDC were to reimburse her for lodging and food.
3. At USAID request, funding was arranged (US $5,130) for Col. Mbareck Diop and Mr. Amadou Mactar for travel to the USGS EROS Data Center in Sioux Falls, South Dakota on October 20-26, 2002.

GISD Project
Annex 1

Subcontract With

University of Rhode Island
IFDC Contract # 01582/01

1. Project Summary Page
2. Project Memorandum of Understanding
3. Project Final Report

	Project Summary Page
MOU Lead Implementation Organization	**University of Rhode Island**
Contact Person	Dr. James Tobey Associate Coastal Manager Coastal Research Center University of Rhode Island Graduate School of Oceanography South Ferry Road Narragansett, RI 02882, USA Telephone: 401/874-6411 or (401)874-6224 tobey@gso.uri.edu
Project/Program and Statement of Work	Target Region 3: Kenya-Tanzania CZM: **Geographic Information for Integrated Coastal Management in Tanzania and Coastal Watershed Management in Kenya** URI will improve national coastal planning, policy and management, and to coordinate local and national coastal resource management in Tanzania and demonstrate "integrated" coastal watershed management similar to successful projects in the Caribbean—a "ridge-to-reef" approach in Kenya. A description of the activities to be undertaken by URI, technical procedures to be followed, deliverables required, and estimated schedule are presented in Attachment 1. Attachment 1 is incorporated as an integral part of this Memorandum of Understanding (MOU).
Collaborating Institutions	Tanzania Environmental Management Council Institute of Marine Sciences University of Dar es Salaam Interagency World Summit Geographic Information Project
IFDC Contract Number	01582/01
Budget Amount	Signed contract with URI for $289,906 on October 29, 2001
Amendment(s)	Amendment 1 dated November 14, 2002, addressed to Jim Tobey modified Articles 2.1 Effective Dates of the MOU and 2.2 Finance.
Extension Ending Date	June 30, 2003

IFDC 01582 01

Memorandum of Understanding

Between

International Fertilizer Development Center
PO Box 2040
Muscle Shoals, AL 35662, USA

And

The University of Rhode Island (URI)
South Ferry Road
Narragansett, RI 02882, USA

October 1, 2001

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Memorandum of Understanding

Between

International Fertilizer Development Center
PO Box 2040
Muscle Shoals, AL 35662, USA

And

The University of Rhode Island (URI)
South Ferry Road
Narragansett, RI 02882, USA

The International Fertilizer Development Center (hereinafter referred to as IFDC) is a public international organization (PIO) dedicated to increasing sustainable agricultural production through the improved use of yield enhancing technologies. The University of Rhode Island (URI) has submitted a proposal to USAID to classify and map resource and land use categories for terrestrial resources (forest, mangroves, river outlets, small islands, urban land, agricultural land, wet land and barren land) in Tanzania and Kenya. In order to carryout the work described herein, IFDC and URI hereby agree to the following terms and conditions:

1.0 INTRODUCTION AND STATEMENT OF WORK

The United States Agency for International Development (USAID) has entered into an Agreement with IFDC for IFDC to undertake a project entitled "Quick Start for Agriculture in Africa" to support the Geographic Information for Sustainable Development (GISD) project leading up to the World Summit on Sustainable Development (WSSD).

IFDC will provide USAID/EGAD/AFS with logistical and management support to the various partners involved in the implementation of the GISD project, including transferring and providing overall fiscal oversight to specific "pass-through" funds to selected partners who are being asked to implement specific GISD activities. This will include work already identified in specific proposals from the NRC, OGC, and several other groups located in the four Target

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2.0 SPECIFIC CONDITIONS

2.1 Effective Dates of MOU

The effective dates of this MOU are October 1, 2001-September 30, 2002.

2.2 Finance

The work to be performed under this MOU is being financed by USAID with all funds channeled to IFDC. IFDC shall provide funding to URI in accordance with the terms and conditions described in this MOU. URI shall develop subagreements as necessary to support funding arrangements and the work to be performed by its collaborating institutions, specifically The Laboratory for Terrestrial Remote Sensing in the Department of Natural Resources Science, The Tanzania Coastal Management Partnership and its Science and Technology Working Group, and NASA. The estimated funds available to URI total US $289,906 (two hundred eighty-nine thousand, nine hundred six) as follows:

Item	Total US $
Personnel	142,434
Travel	48,061
Equipment	30,300
Operating Expenses	13,000
Subtotal	**233,795**
Indirect	56,111
TOTAL	**289,906**

2.2.1 Use of Funds

IFDC has fiduciary responsibility of funds received from USAID. Under the terms of this MOU, all funds provided to URI shall be utilized solely for the purposes indicated in the budget under 2.2. Said funds shall cover all expenditures necessary for the services to be performed by and or arranged by URI. IFDC shall not be responsible for any additional costs (i.e., above US $289,906) incurred in the performance of the work described under this MOU.

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2.2.4 Financial Reports

URI shall provide to IFDC, within 20 days of the end of each month under this program, a financial report that shall include accounting for all allowable costs incurred by URI under the program in accordance with the line item budget amounts indicated in 2.2. Financial Summary Reports list total award, total expenditures to date, current month expense and balance available. These reports will accompany the invoice (2.2.3 Payments).

Copies of documentation to support all costs incurred in performance of work described in this MOU shall be made available to IFDC upon request by USAID.

2.2.5 Audit

URI shall maintain books, records, documents, and other evidence in accordance with URI's usual accounting procedures to sufficiently substantiate charges to this MOU. IFDC and USAID reserve the right to examine and URI agrees to make available all financial records and documents of URI as related to this MOU. Any costs that are determined by either IFDC or USAID to be inconsistent with the terms and conditions of this MOU shall immediately be refunded to IFDC. URI is subject to the audit guidelines and provisions of 22 CFR Section 226.26. In accordance with the provisions of OMB Circular A-133, URI is obligated to comply with the requirements of OMB Circular A-133. URI is required to have an audit in full compliance with the guidelines of OMB A-133 and agrees that a copy of the audit report will be submitted to IFDC's supervisor, Accounting Services, by URI within thirty (30) days of completion of the audit. By the signing of this MOU, URI states that they were informed of, understand, and agree to comply with the applicable compliance requirements.

2.2.6 Refunds

(a) If URI earns interest on advances under this MOU prior to expending the funds for program purposes, URI shall remit the interest to IFDC or deduct

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funding allocated among objectives by more than ten percent of the total budget amount unless the schedule states otherwise.

- Additional funding is needed.
- URI expects the amount of authorized funds to exceed its needs by more than $5,000 or five percent of the MOU budget, whichever is greater.

(c) Except as required by other provisions of this MOU specifically stated to be an exception from this provision, IFDC shall not be obligated to reimburse URI for costs incurred in excess of the total amount obligated under the MOU. URI shall not be obligated to continue performance under the MOU (including actions under the "Termination Procedures" provision) or otherwise to incur costs in excess of the amount obligated under the MOU, unless and until IFDC has notified URI in writing that such obligated amount has been increased and has specified the new MOU total amount.

2.6 Other Terms and Conditions

The following terms and conditions, which are applicable to the MOU by and between USAID and IFDC, shall be integral part of this Agreement.

2.6.1 Official Contacts

The contacts under this MOU for all official contacts are as follows:

IFDC Technical
Dr. Lawrence L. Hammond
Director, Research and Development Division
IFDC
PO Box 2040
Muscle Shoals, AL 35662, USA
Telephone: 256/381-6600, extension 270
FAX: 256/381-7408
lhammond@ifdc.org
www.ifdc.org

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URI shall provide the relevant strategic objective or results package team with one copy of all published works developed under this MOU and with lists of other written work produced under the MOU.

Except as otherwise provided in the terms and conditions of the MOU, the author or URI is free to copyright any books, publications, or other copyrightable materials developed in the course of or under this MOU, but USAID reserves a royalty-free nonexclusive and irrevocable right to reproduce, publish, or otherwise use, and to authorize others to use the work for U.S. Government purposes.

2.6.3 Reports and Data

URI shall send to the IFDC Technical Contact at the address included in this MOU, monthly and quarterly progress reports in a form and substance satisfactory to IFDC. The monthly reports will provide a brief report on the status of activities being undertaken to implement this project during the previous 30 days.

The quarterly reports shall indicate progress toward achieving Program objectives and implementing approved work plans. The reports shall include, but not be limited to, the following information:

- Status of achievement of program goals, objectives, and benchmarks specified in the annual work plan
- Progress or completion of components, elements, or activities against planned targets
- Program description
- Other accomplishments or program highlights
- Identification and explanation of significant problems which have been encountered
- Description of planned corrective action

2.6.5 Dispute Settlement

Because of the nature of this agreement and legal status of the respective organizations engaged under this MOU, reconciliation of disputes which cannot be handled amicably will be settled through discussions/negotiations by and between the signatories to the MOU.

2.6.6 Investment Promotions

No funds or other support provided hereunder may be used in a program or activity reasonably likely to involve the relocation or expansion outside of the United States of an enterprise located in the United States if non-US production in such relocation or expansion replaces some or all of the production of, and reduces the number of employees at, said enterprise in the United States.

No funds or other support provided hereunder may be used in a program or activity the purpose of which is the establishment or development in a foreign country of any export processing zone or designated area where the labor, environmental, tax, tariff, and safety laws of the country would not apply, without the prior written approval of IFDC.

No funds or other support provided hereunder may be used in an activity which contributes to the violation of internationally recognized rights of workers in the recipient country including those in any designated zone or area in that country. This provision must be included in all subagreements.

Memorandum of Understanding

Between

International Fertilizer Development Center
PO Box 2040
Muscle Shoals, AL 35662, USA

And

The University of Rhode Island (URI)
South Ferry Road
Narragansett, RI 02882, USA

The International Fertilizer Development Center (hereinafter referred to as IFDC) is a public international organization (PIO) dedicated to increasing sustainable agricultural production through the improved use of yield enhancing technologies. The University of Rhode Island (URI) has submitted a proposal to USAID to classify and map resource and land use categories for terrestrial resources (forest, mangroves, river outlets, small islands, urban land, agricultural land, wet land and barren land) in Tanzania and Kenya. In order to carryout the work described herein, IFDC and URI hereby agree to the following terms and conditions:

1.0 INTRODUCTION AND STATEMENT OF WORK

The United States Agency for International Development (USAID) has entered into an Agreement with IFDC for IFDC to undertake a project entitled "Quick Start for Agriculture in Africa" to support the Geographic Information for Sustainable Development (GISD) project leading up to the World Summit on Sustainable Development (WSSD).

IFDC will provide USAID/EGAD/AFS with logistical and management support to the various partners involved in the implementation of the GISD project, including transferring and providing overall fiscal oversight to specific "pass-through" funds to selected partners who are being asked to implement specific GISD activities. This will include work already identified in specific proposals from the NRC, OGC, and several other groups located in the four Target

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Regions: Upper Niger Basin, African Great Lakes Region, the Kenya-Tanzania Coastal Zone, and the Limpopo/Zambeze River Basin Region of southern Africa.

IFDC will work in close collaboration with the technical officers within USAID providing oversight: Note: The Overall Coordinator is Robert E. Ford, AEMD – Agricultural Enterprise and Market Development Division within USAID's office of Agriculture and Food Security. Robert E. Ford is the Chair of the GISD-IWG for Regional Applications sub-group.

Close coordination must also occur with co-Chairs of the GISD-IWG for each sub-region. They are: Barbara Best (G/ENV) for the Kenya-Tanzania CZM Activity; Paul Bartel and Jon Anderson (AFR-SD) for the Four Corners/Limpopo/Zambezi Basin region; Robert Ford for the Great Lakes/Great Horn of Africa Region; and Mike McGahuey (USAID/AFR-SD).

URI will work to improve national coastal planning, policy and management, and coordinate local and national coastal resource management in Tanzania. It will demonstrate remote sensing tools and GSI information can be effectively utilized in within an Integrated Coastal Management program. A description of the activities to be undertaken by URI, technical procedures to be followed, deliverables required, and estimated schedule are presented in Attachment 1, which is incorporated as an integral part of this Memorandum of Understanding (MOU).

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2.0 SPECIFIC CONDITIONS

2.1 Effective Dates of MOU

The effective dates of this MOU are October 1, 2001-September 30, 2002.

2.2 Finance

The work to be performed under this MOU is being financed by USAID with all funds channeled to IFDC. IFDC shall provide funding to URI in accordance with the terms and conditions described in this MOU. URI shall develop subagreements as necessary to support funding arrangements and the work to be performed by its collaborating institutions, specifically The Laboratory for Terrestrial Remote Sensing in the Department of Natural Resources Science, The Tanzania Coastal Management Partnership and its Science and Technology Working Group, and NASA. The estimated funds available to URI total US $289,906 (two hundred eighty-nine thousand, nine hundred six) as follows:

Item	Total US $
Personnel	142,434
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Operating Expenses	13,000
Subtotal	**233,795**
Indirect	56,111
TOTAL	**289,906**

2.2.1 Use of Funds

IFDC has fiduciary responsibility of funds received from USAID. Under the terms of this MOU, all funds provided to URI shall be utilized solely for the purposes indicated in the budget under 2.2. Said funds shall cover all expenditures necessary for the services to be performed by and/or arranged by URI. IFDC shall not be responsible for any additional costs (i.e., above US $289,906) incurred in the performance of the work described under this MOU.

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2.2.2 Allowable Costs

(a) URI shall be reimbursed for costs incurred in carrying out the purposes of this MOU, which are reasonable, allocable, and allowable.

(b) Reasonable shall mean those costs that do not exceed those which would be incurred by an ordinarily prudent person in the conduct of normal business.

(c) Allocable shall mean those costs that are necessary to the MOU.

(d) Allowable shall mean those costs which are reasonable and allocable, and which conform to any limitations set forth in this MOU.

(e) Prior to incurring a questionable or unique cost, URI is encouraged to obtain IFDC's written determination as to whether the cost will be allowable.

2.2.3 Payments

IFDC shall make payments to URI subject to the receipt of funds from USAID and based upon receipt of an official invoice from URI. The invoice may be faxed to the official IFDC Business Contact indicated in 2.6.1. The payments shall be made on a monthly basis upon submission URI's monthly invoices supported by financial summary reports (2.2.4 Financial Reports)

2.2.4 Financial Reports

URI shall provide to IFDC, within 20 days of the end of each month under this program, a financial report that shall include accounting for all allowable costs incurred by URI under the program in accordance with the line item budget amounts indicated in 2.2. Financial Summary Reports list total award, total expenditures to date, current month expense and balance available. These reports will accompany the invoice (2.2.3 Payments).

Copies of documentation to support all costs incurred in performance of work described in this MOU shall be made available to IFDC upon request by USAID.

2.2.5 Audit

URI shall maintain books, records, documents, and other evidence in accordance with URI's usual accounting procedures to sufficiently substantiate charges to this MOU. IFDC and USAID reserve the right to examine and URI agrees to make available all financial records and documents of URI as related to this MOU. Any costs that are determined by either IFDC or USAID to be inconsistent with the terms and conditions of this MOU shall immediately be refunded to IFDC. URI is subject to the audit guidelines and provisions of 22 CFR Section 226.26. In accordance with the provisions of OMB Circular A-133, URI is obligated to comply with the requirements of OMB Circular A-133. URI is required to have an audit in full compliance with the guidelines of OMB A-133 and agrees that a copy of the audit report will be submitted to IFDC's supervisor, Accounting Services, by URI within thirty (30) days of completion of the audit. By the signing of this MOU, URI states that they were informed of, understand, and agree to comply with the applicable compliance requirements.

2.2.6 Refunds

(a) If URI earns interest on advances under this MOU prior to expending the funds for program purposes, URI shall remit the interest to IFDC or deduct

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the same from subsequent invoices of planned monthly expenditures in accordance with 2.2.3.

(b) Funds not disbursed to URI at the time the MOU expires or is terminated shall revert to IFDC, except for such funds encumbered by URI by a legally binding transaction applicable to this MOU. Any funds advanced to but not expended by URI at the time of expiration or termination of the MOU shall be refunded to IFDC except for such funds encumbered by URI by a legally binding transaction applicable to this MOU.

(c) If, at any time during the life of the MOU, or as a result of final audit, it is determined that funds provided under this MOU have been expended for purposes not in accordance with the terms of this MOU, URI shall refund such amount to IFDC.

2.3 Language

The MOU has been executed in English, which shall be the binding and controlling language for interpretation of the terms and conditions of this MOU.

2.4 Subagreements

It is understood that URI may carryout the work described under this MOU in collaboration with others. It is further understood that funds provided to URI may be used to support work carried out by collaborating institutions. URI shall ensure that the specific conditions of this MOU (i.e., Section 2.0, Specific Conditions) shall apply to all such subagreements.

2.5 Revision of MOU Budget

(a) The approved MOU budget is the financial expression of URI's program.

(b) URI shall immediately request approval from IFDC when there is reason to believe that within the next 30 calendar days a revision of the approved MOU budget will be necessary for any of the following reasons:

- To change the scope or the objectives of the program and/or revise the

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funding allocated among objectives by more than ten percent of the total budget amount unless the schedule states otherwise.

- Additional funding is needed.
- URI expects the amount of authorized funds to exceed its needs by more than $5,000 or five percent of the MOU budget, whichever is greater.

(c) Except as required by other provisions of this MOU specifically stated to be an exception from this provision, IFDC shall not be obligated to reimburse URI for costs incurred in excess of the total amount obligated under the MOU. URI shall not be obligated to continue performance under the MOU (including actions under the "Termination Procedures" provision) or otherwise to incur costs in excess of the amount obligated under the MOU, unless and until IFDC has notified URI in writing that such obligated amount has been increased and has specified the new MOU total amount.

2.6 Other Terms and Conditions

The following terms and conditions, which are applicable to the MOU by and between USAID and IFDC, shall be integral part of this Agreement.

2.6.1 Official Contacts

The contacts under this MOU for all official contacts are as follows:

IFDC Technical
Dr. Lawrence L. Hammond
Director, Research and Development Division
IFDC
PO Box 2040
Muscle Shoals, AL 35662, USA
Telephone: 256/381-6600, extension 270
FAX: 256/381-7408
lhammond@ifdc.org
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IFDC Business
Mr. John H. Allgood
Director, Finance, Administration, and Support Services
IFDC
PO Box 2040
Muscle Shoals, AL 35662, USA
Telephone: 256/381-6600, extension 211
FAX: 256/381-7408
jallgood@ifdc.org
www.ifdc.org

URI Technical/Business
Dr. James Tobey
Associate Coastal Manager
Coastal Resources Center
University of Rhode Island
Graduate School of Oceanography
South Ferry Road
Narragansett, Rhode Island, USA 02882
Telephone: 401/874-6411 or 401/874-6224
tobey@gso.uri.edu

2.6.2 Publications and Media Releases

If it is URI's intention to identify USAID's contribution to any publication, video or other information/media product resulting from this MOU, URI shall state that the views expressed by the author(s) do not necessarily reflect those of USAID. Acknowledgements should identify the sponsoring USAID Office and Bureau or Mission as well as USAID substantially as follows:

"This [publication, video or other information/media project (specific)] was made possible through support provided by the Center for Economic Growth and Agricultural Development, Office of Agriculture and Food Security, under the terms of the MOU. The opinions expressed herein are those of the author(s) and do not necessarily reflect the views of USAID."

URI shall provide the relevant strategic objective or results package team with one copy of all published works developed under this MOU and with lists of other written work produced under the MOU.

Except as otherwise provided in the terms and conditions of the MOU, the author or URI is free to copyright any books, publications, or other copyrightable materials developed in the course of or under this MOU, but USAID reserves a royalty-free nonexclusive and irrevocable right to reproduce, publish, or otherwise use, and to authorize others to use the work for U.S. Government purposes.

2.6.3 Reports and Data

URI shall send to the IFDC Technical Contact at the address included in this MOU, monthly and quarterly progress reports in a form and substance satisfactory to IFDC. The monthly reports will provide a brief report on the status of activities being undertaken to implement this project during the previous 30 days.

The quarterly reports shall indicate progress toward achieving Program objectives and implementing approved work plans. The reports shall include, but not be limited to, the following information:

- Status of achievement of program goals, objectives, and benchmarks specified in the annual work plan
- Progress or completion of components, elements, or activities against planned targets
- Program description
- Other accomplishments or program highlights
- Identification and explanation of significant problems which have been encountered
- Description of planned corrective action

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The monthly and quarterly reports may be submitted in electronic format and are to be delivered to IFDC within 7 calendar days and 20 calendar days, respectively, of the end of the reporting period. A final report addressing the same components included in the quarterly report is to be submitted to IFDC by URI within 45 calendar days of the ending date of this MOU. The reports submitted to URI to IFDC and supporting materials compiled in performing the services shall be the property of USAID.

URI is also required to submit copies of reports/publications, produced within each activity as requested by the USAID Cognizant Technical Officer (e.g., workshop proceedings, PowerPoint presentations, etc.).

2.6.4 Termination

This agreement may be terminated, in whole or in part, by either party at any time upon 30 days written notice of termination. Upon receipt of and in accordance with a termination notice from the IFDC, the URI shall take immediate action to cease all expenditures financed by this MOU and to cancel all unliquidated obligations if possible. Further, upon receipt of notice of termination, the URI shall not enter into any further obligations under this MOU. Except as provided below, no further reimbursement shall be made after the effective date of termination. The URI shall within 30 days of the effective date of termination repay to IFDC all unexpended funds that are not otherwise obligated by a legally binding transaction applicable to this MOU. Should the funds paid by IFDC to the URI prior to the effective date of termination be insufficient to cover the URI's obligations in a legally binding transaction, the URI may submit to IFDC within 90 days after the effective date of termination a written claim for such amount. The IFDC shall determine the amount(s) to be paid by IFDC to the URI under such claim in accordance with the "Allowable Costs" provision of this MOU.

2.6.5 Dispute Settlement

Because of the nature of this agreement and legal status of the respective organizations engaged under this MOU, reconciliation of disputes which cannot be handled amicably will be settled through discussions/negotiations by and between the signatories to the MOU.

2.6.6 Investment Promotions

No funds or other support provided hereunder may be used in a program or activity reasonably likely to involve the relocation or expansion outside of the United States of an enterprise located in the United States if non-US production in such relocation or expansion replaces some or all of the production of, and reduces the number of employees at, said enterprise in the United States.

No funds or other support provided hereunder may be used in a program or activity the purpose of which is the establishment or development in a foreign country of any export processing zone or designated area where the labor, environmental, tax, tariff, and safety laws of the country would not apply, without the prior written approval of IFDC.

No funds or other support provided hereunder may be used in an activity which contributes to the violation of internationally recognized rights of workers in the recipient country including those in any designated zone or area in that country. This provision must be included in all subagreements.

2.6.7 Non-Liability

IFDC does not assume liability for any third party claims for damages arising out of this MOU.

2.6.8 Notices

Any notice given by either party under this MOU shall be sufficient only if in writing and delivered in person or faxed to the official contact persons identified in 2.5.1

2.6.9 Special Provisions

URI shall comply with USAID environmental regulations (22 CFR Section 216 "Regulation 16") with respect to the activities to be undertaken under this MOU.

2.6.10 Procurement Policies and Procedures

Because USAID is the sole contributor, USAID procurement policies and procedures are applicable (22 CFR Section 226 and ADS 308.5.7a).

2.6.11 *Ineligible Countries*

Activities under this agreement may only be carried out in countries that are eligible to receive assistance under the Foreign Assistance Act. URI shall provide IFDC in advance a list of those countries where activities are planned under this MOU.

2.6.12 Entire MOU

Unless otherwise specified, this MOU embodies the entire understanding between IFDC and URI for the services to be provided and any prior to contemporaneous representations, either oral or written, are hereby superseded. No amendments or changes to this MOU, including, without limitation, changes in the statement of work, total estimated cost, and period of performance, shall be effective unless made in writing and signed by authorized representatives of the parties.

FOR AND ON BEHALF OF IFDC

By: LLHammond

Name: LAWRENCE HAMMOND

Title: Director, RDD

Date: 10-29-01

FOR AND ON BEHALF OF URI

By:

Name: JANETT TRUBATCH

Title: VICE PROVOST FOR RESEARCH

Date: 10/3/01

WITNESS:

By: Dan Waterman

Name: DAN WATERMAN

Title: DEV. OFFICER

Date: 10/29/01

WITNESS:

By: Rosemary White

Name: Rosemary White

Title: Specialists Contracts and Grants

Date: 10/3/01

C. Target Region 3: Kenya-Tanzania CZM:

Geographic Information for Integrated Coastal Management in Tanzania And Coastal Watershed Management in Kenya

The Tanzania Coastal Management Partnership – Scope of Present Project

A partnership involving the Tanzanian Environmental Management Council (NEMC), the University of Rhode Island and USAID was established in 1997 to improve national coastal planning, policy and management, and to coordinate local and national coastal resource management. The Tanzania Coastal Management Partnership (TCMP) works with the existing network of integrated coastal management (ICM) programs and practitioners to promote a participatory, transparent process to unite government and community, science and management, and private and public interests to wisely conserve and develop coastal ecosystems and resources.

The partnership has produced a national coastal policy that has been approved by all major stakeholders and is under Cabinet review for legal adoption. Tanzania is a recognized leader in East and South Africa in integrated coastal management. In addition to development of an overall coastal policy framework, interagency working groups have produced guidelines and improved human and institutional capacity for promoting sustainable coastal aquaculture development. Other working groups are currently focusing on coastal management issues in tourism development and supporting coastal action planning in Districts. The initiative also has a vigorous public awareness program and a training program that includes resource practitioners who are trying to deal with both the immediate resource needs of impoverished communities and the long-term goals of ensuring a sustainable economic basis for future generations. The partnership provides expertise and national coordination on coastal resource management in Tanzania and also contributes to regional advancement of coastal management in the East African region.

XII. Coastal Zone of Tanzania – Of Critical Importance to Economic Development and Food Security

Tanzania's coastline stretches for 800 km. The five coastal regions contribute about one third of the national Gross Domestic Product (GDP), and contain about 75 percent of the country's industries. Newly initiated activities in the coastal

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region, including coastal tourism, mariculture development and natural gas exploitation, are seen as potential resources for national economic development. However, much of the coastline is remote and pristine, with fringing coral reefs along two thirds of the coastline. Rapid development and population growth threaten coral reefs, fish breeding areas, and other coastal resources that are critical to food security and the livelihoods of coastal villages and future economic growth.

Better Information for Decision-making and Coastal Monitoring - A National Priority

The need for better information for decision-making has been identified by the partnership and within the draft coastal policy as a priority issue. A Science and Technical Working Group (STWG) was formed in 1998 with scientists from the Institute of Marine Sciences (IMS) of the University of Dar es Salaam, other University departments, and the national marine fisheries research institute. The Director of IMS serves as the chairperson. STWG functions as the bridge between coastal managers and the science and research community. The STWG mandate as defined in the national coastal policy includes the best use of scientific information available for improved decision making and management.

Proposed Application of Geographic Information Data

Government agencies responsible for coastal resource planning and management require reliable information to develop and promote sustainable coastal development policies and actions. Strategic interventions based on reliable knowledge are critical because public sector resources are scarce and must be well targeted, and the rate of change is rapid. A doubling of the coastal population is predicted in as little as twelve years. That could mean 16 million people living on the coast in 2010. This proposal would support the STWG mandate by providing a data rich inventory of Tanzania's present coastal resources and land use, and an assessment of land-use trends over the last ten years.

The project would classify and map resource and land use categories for terrestrial resources (forest, mangroves, river outlets, small islands, urban land, agricultural land, wetland, and barren land). Terrestrial land use, especially agriculture and forestry are critical to sustainable coastal development and planning. Additional resources would be required to classify and map submerged near shore elements (seagrass and coral reefs). The proposed area of application is the entire mainland coast inward to the boundary of coastal districts and including the islands of Pemba and Unguja.

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The processing of satellite data and construction of GIS maps will help analyze rates of change over time in resource and land use patterns, and identify priority locations for coastal action planning, special area management, aquaculture siting, tourism development planning, and land use zoning. These activities are described in the national coastal policy as priorities of the Tanzanian national coastal management effort. They are management actions that the TCMP and the Tanzanian government, private sector, and civil society are currently tackling. The project will provide a major boost to a long-term, sustained effort in the use of science for coastal management. The project builds on state of the coast monitoring and assessment that STWG has been conducting through exhaustive surveys of literature and village focus group interviews in coastal districts.

XIII. Institutional Capability to Apply Data and Impact Resource Management

TCMP and its partners have the institutional capability and demonstrated commitment to apply earth observation data and enabling technologies to specific natural resource management problems and make a difference. The project will build Tanzania's capacity to utilize the technologies from this project in myriad applications. The TCMP effort has established mechanisms for sustainability so that progress continues once USAID project funding ends. The activities initiated by TCMP have the staying power so that data collected from the field and from satellites can be used to monitor changes over time.

The Institute of Marine Science is the institutional home of the Science and Technical Working Group. IMS is a recognized center of excellence in marine sciences in Africa and has strong connections to international research organizations. IMS scientists are developing capabilities in GIS technologies and in the application of new techniques to earth observation data. Several IMS scientists have participated in earth observation data training and planning activities of international organizations, such as UNESCO/IOC and the International Institute for Aerospace Survey and Earth Sciences.

XIV. *Collaborating Institutions*

The principal project implementing partners are the Laboratory for Terrestrial Remote Sensing in the Department of Natural Resources Science, University of Rhode Island; the Tanzania Coastal Management Partnership and its Science and Technical Working Group; NASA; and the Coastal Resources Center, University of Rhode Island.

Key collaborating institutions are the Institute of Marine Sciences, University of Dar es Salaam; National Environment

Management Council; Interagency World Summit Geographic Information Project; USAID Global Bureau and the USAID Tanzania Mission.

The project and future applications will be conducted in coordination with regional partners in coastal management including the Western Indian Ocean Marine Science Association (WIOMSA), SEACAM, World Fund for Nature (WWF)/Tanzania, Global Environment Facility, and other international agencies active in remotely sensed coastal data and analysis (e.g. UNESCO/IOC and the International Institute for Aerospace Survey and Earth Sciences).

Coastal Watershed Management in Kenya
USAID/Kenya is starting a major new integrated watershed, forestry and parks management program in the upstream portion of the watershed that enters the ocean at Malindi. This project will be an opportunity to demonstrate "integrated" coastal watershed management similar to successful projects in the Caribbean - a "ridge-to-reef" approach. The Malindi/Shimba Hills Forest region lies just north of the Tanzania border. This coastal waster shed may be included in the geographic analysis of the Landsat data for the Tanzanian project, for use by the Malindi partners. This inclusive analysis will present a broad regional view of the status and trends of the coastal resources, including coral reefs and mangroves, which have been identified by the World Wildlife Fund as the one of the top eco-regions of international significance.

Funding Requirements

XV.

A) Condensed (full budget is given in accompanying Excel spreadsheet)

	CRC/URI	LTRS/URI	TCMP/STWG	NOAA (1)	Totals
Personnel	23,407	114,027	5,000	-	142,434
Travel		20,796	27,265		48,061
Equipment	5,000	5,000	20,300	-	30,300
Operating	3,000	5,000	5,000	-	13,000
Total Direct Costs	31,40	144,823	57,565	-	233,795
Indirect Costs (2)	7,538	34,758	13,816	-	56,111

Total	38,945	179,581	71,381	(125,000)	289,906

(1) The proposed budget covers remote imaging, analysis and capacity building for the terrestrial component only. There is also a strong need within Tanzania for an analysis of submerged coastal resources using remote sensing technology. NOAA has offered its expertise and assistance in this project; to include submerged resources, an additional $125,000 is required.

B) Additional funding requirements

The proposed budget covers remote imaging, analysis and capacity building for the terrestrial component only. There is also a strong need within Tanzania for an analysis of submerged coastal resources using remote sensing technology. Land-use planning should be closely linked with coastal planning, such as proper siting for future mariculture projects. NOAA has offered to assist in this component of the project; NOAA's expertise on remote mapping and characterization of submerged coastal resources would greatly add to the project and to planning efforts within Tanzania. To include submerged resources, it is an estimated that an additional $125,000 is required.

See attached EXCEL Spreadsheet.

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IFDC INTERNATIONAL FERTILIZER DEVELOPMENT CENTER • MUSCLE SHOALS, ALABAMA 35662 USA
P.O. BOX 2040 • 256-381-6600
EMAIL-general@IFDC.org
TELEFAX NO. 256-381-7408

November 14, 2002

Dr. James Tobey
Associate Coastal Manager
Coastal Resources Center
University of Rhode Island
Graduate School of Oceanography
South Ferry Road
Narragansett, RI 02882

Dear Dr. Tobey:

Amendment Number 1 to MOU between the International Fertilizer Development Center (IFDC) and the University of Rhode Island (URI)

This letter shall serve as Amendment Number 1 to the Memorandum of Understanding between IFDC and URI to support the Geographic Information for Sustainable Development (GISD) project. The parties to the MOU agree that articles **2.1 Effective Date of the MOU** and **2.2 Finance** are hereby changed as follows:

2.1 Effective Date of the MOU

The effective dates of this MOU are October 1, 2001 – June 30, 2003.

2.2 Finance

Item	Total US $
Personnel	142,434
Travel	27,965
Equipment	30,360
Operating Expenses	33,036
Subtotal	**233,795**
Indirect	56,111
TOTAL	**289,906**

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All other terms and conditions of the MOU by and between IFDC and URI shall remain in full force and effect. If you concur, please return one signed copy to IFDC for our records.

Sincerely yours,

for A. H. Roy.

Amit H. Roy
President and Chief Executive Officer

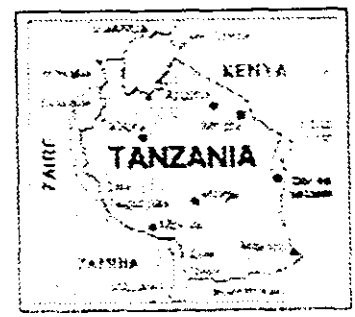
ACCEPTED AND AGREED TO:

James B. Tobey

University of Rhode Island

Geographic Information for Sustainable Development

Final Report of the Tanzania Coastal Zone Change Analysis Project



Project Summary

The project on coastal land cover change in Tanzania is part of the Geographic Information for Sustainable Development (GISD) initiative that was introduced in 2001 by the United States government in response to the recommendations of Agenda 21. GISD is an international alliance that shares the goal of increasing local capabilities to apply earth observation data and geographic information technologies in Africa for improved decision-making on sustainable development problems. All projects link environmental and natural resource management to sustainable development.

The Tanzania GISD project was initiated in November 2001 with the financial support of USAID. It was jointly lead by two centers located in the University of Rhode Island in partnership with the Tanzania National Environment Management Council and the Tanzania Coastal Management Partnership. The URI centers are the Coastal Resources Center in the Graduate School of Oceanography and the Laboratory of Terrestrial and Remote Sensing in the College of Environment and Life Sciences.

Remotely sensed images from 1990 Landsat Thematic Mapper sensor and 2000 Landsat-7 Enhanced Thematic Mapper Plus sensor and geographic information system technologies were applied to discern changes in land cover and land use along the mainland Tanzania coast. This provided the first comprehensive scientific data in a recent time period on land-use and land-cover change in the coastal zone of Tanzania.

The project was built on an existing national integrated coastal management planning and policy initiative—the Tanzania Coastal Management Partnership (TCMP). This initiative is a partnership of the government of Tanzania, USAID, and the Coastal Resources Center. The TCMP was established in 1997 to connect locally based coastal and marine management efforts and enhance integrated coastal management at the national level.

The need for better information for decision-making has been identified as a national priority by Tanzania's national coastal management program. A national Strategy Paper was adopted by Cabinet in November 2002. The National Strategy identifies the need for better coastal data on resource status, trends, and uses as one of six priority issues.

The GISD project in Tanzania was designed to enhance the spatial information capabilities of Tanzania's coastal management efforts. Accurate information regarding urban development, woodland change, and mangrove distribution are critical to coastal resource management. The database and spatial information capabilities from the project will be used in such areas as District planning, special area management, and land use zoning.

The geospatial information from this project will help obtain scientific consensus on the nature of conservation problems and increase the legitimacy and acceptability of policy options. Remote sensing and the derivatives of data from this study provide a foundation for integrated coastal resource planning, targeted field studies, and monitoring. The GIS database provides a baseline for future land cover and land use assessments, and a framework for integration with social and economic data in order to connect with human concerns such as poverty alleviation and food security.

Outcomes and Accomplishments

- Land use and land cover maps for both 1990 and 2000 of the coastal administrative Regions of mainland Tanzania completed
- CD-ROM of data files (1990, 2000 and change analysis) and hard copy maps at 1:50,000 scale provided to National Environment Management Council (NEMC) and Tanzania Coastal Management Partnership
- Project maps made available online through an Internet Mapping Server (IMS) installed and hosted from the University of Rhode Island
- Intensive hands-on staff training for Tanzanian partners, study tours to URI and infrastructure support together established in-country capabilities for the use of spatial information in support of policy and management. Institutional capacity building was targeted at the GIS office of the National Environment Management Council
- Equipment and software provided to Tanzania office: Dell laptop and Trimble Geoexplore III GPS unit for GPS-guided field investigation, high-resolution digital camera, Dell computer, ERDAS Imagine and ArcView software
- Hands-on training of two Tanzanian scientists at the URI Laboratory of Terrestrial Remote Sensing in ERDAS Imagine software, Landsat image data examination, training signature identification, area of interest selection, land use and land cover classification, mosaicking, GIS operations, and classification and accuracy assessment
- The ripple effect benefits of the database and acquired RS/GIS competency are evidenced by the fact that the NEMC/GIS Unit now receives requests for assistance from the government, Universities and other local and international institutions
- GPS-guided field reconnaissance was conducted in Tanzania from February 2003. The project team traveled through all Tanzania mainland coastal districts, covering 3,500 km by road. The team collected 651 GPS transects totaling 979 km in distance, 1,360 GPS photos, 87 GOS points, and 540 regular photos
- Paper published on project findings in *Marine Geodesy*, 2003, Vol. 26, pp. 35-48, "Remote Sensing of Mangrove Change along the Tanzania Coast"
- Second project paper submitted (August 2003) to *Coastal Management* journal. Title: "Remote Sensing of Land-Cover Change along the Tanzania Coast for Integrated Coastal Management and Sustainable Development"
- Project products contributed substantively to the "Tanzania State of the Coast Report 2003." This document is produced by the TCMP, signed by the Vice-President's Office and distributed widely
- Shoreline change analysis in the Kinondoni Municipality and field survey research on mangrove change in the Rufiji Delta were conducted in partnership with the TCMP Science and Technical Working Group. Results were published and disseminated in the Tanzania State of the Coast Report 2003

- Workshops and conference presentations of the Tanzania/GISD project:

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  Annual Conference of the American Society of Photogrammetry and Remote Sensing (ASPRS), special session on Sustainable Development, Anchorage, Alaska, May 2003

Recommendations for Further Work

1. The GIS database needs to be extended to islands and submerged aquatics (primarily seagrass and coral).

2. A second need is to build layers of socio-economic information into the geographic database to give coastal management professionals the tools to monitor and assess natural resource inventories, environmental change, and poverty. Livelihoods, environment, and poverty reduction are main objectives of Tanzanian Government policy. The Government of Tanzania's Poverty Reduction Strategy Paper (PRSP) and Development Vision 2025 articulate the importance of sustainable environmental management for poverty reduction. It recognizes that the poor in Tanzania are heavily dependent on the environment and natural resources for their livelihood and income generation and therefore, emphasizes mainstreaming environmental sustainability into poverty reduction efforts. Linking spatial

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information on land use and land cover with data on household and village characteristics would be valuable for policy development and management efforts.

3. A third need would be to build capacity and long-term working partnerships between the primary spatial information centers in Tanzania. Capacity in Tanzania overall remains limited in spatial information technologies. Given the resources and timeframe of this GISD project, we chose to emphasize capacity building in the policy and planning institution—the National Environment Management Council. However, it would be desirable to build a complementary relationship between the scientific and technical expertise of the University of Dar es Salaam and the National Environment Management Council. Ideally, the GIS Unit in NEMC should be the office that converts spatial information for management applications, and the Institute of Marine Sciences of the University of Dar es Salaam should be the location for the scientific and technical construction and updating of spatial maps and databases on coastal and marine resources.

This report prepared by

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Department of Natural Resources Sciences
University of Rhode Island

Dr. James Tobey (Tobey@gso.uri.edu)
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COASTAL RESOURCES CENTER

University of Rhode Island

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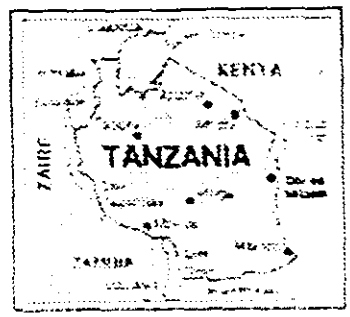

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2. A second need is to build layers of socio-economic information into the geographic database to give coastal management professionals the tools to monitor and assess natural resource inventories, environmental change, and poverty. Livelihoods, environment, and poverty reduction are main objectives of Tanzanian Government policy. The Government of Tanzania's Poverty Reduction Strategy Paper (PRSP) and Development Vision 2025 articulate the importance of sustainable environmental management for poverty reduction. It recognizes that the poor in Tanzania are heavily dependent on the environment and natural resources for their livelihood and income generation and therefore, emphasizes mainstreaming environmental sustainability into poverty reduction efforts. Linking spatial

information on land use and land cover with data on household and village characteristics would be valuable for policy development and management efforts.

3. A third need would be to build capacity and long-term working partnerships between the primary spatial information centers in Tanzania. Capacity in Tanzania overall remains limited in spatial information technologies. Given the resources and timeframe of this GISD project, we chose to emphasize capacity building in the policy and planning institution—the National Environment Management Council. However, it would be desirable to build a complementary relationship between the scientific and technical expertise of the University of Dar es Salaam and the National Environment Management Council. Ideally, the GIS Unit in NEMC should be the office that converts spatial information for management applications, and the Institute of Marine Sciences of the University of Dar es Salaam should be the location for the scientific and technical construction and updating of spatial maps and databases on coastal and marine resources.

This report prepared by

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COASTAL RESOURCES CENTER

University of Rhode Island

GISD Project
Annex 2

Subcontract With
International Center for Research in Agroforestry (ICRAF)
IFDC Contract # 01583/01

1. Project Summary Page
2. Project Memorandum of Understanding
3. Project Final Report

Project Summary Page

MOU Lead Implementation Organization	**ICRAF**
Contact Person	Dr. David Siriri Acting ICRAF Coordinator for Kabale USAID Project International Centre for Research in Agroforestry PO Box 30677, Nairobi, Kenya Telephone: +254 2 521450 or +1 650 833 6645 Fax: +254 2 521001 or +1 650 833 6646 ICRAF@cgiar.org
Project/Program and Statement of Work	Target Region 2: African Great Lakes: AFRENA-ICRAF **Implementation of Geographic Information System to Support Sustainable Development: Improving Land Management and Policy-Marketing at the Local Community/Local Authority Level in Southwest Uganda** ICRAF will (1) document impacts of current land management practices and socio-eco-political factors (Changes in biophysical parameters related to natural resource base condition and producer behavior, Delineate areas of conservation and development conflicts, Explain changes in terms of policy and institutional frameworks; (2) Develop spatial tools to support soil and water conserving and local community development efforts; and (3) Enhance African institutional capacity in the use of GIS/Remote Sensing and other geo-spatial decision support tools. A description of the activities to be undertaken by ICRAF, technical procedures to be followed, deliverables required, and estimated schedule are presented in Attachment 1. Attachment 1 is incorporated as an integral part of this Memorandum of Understanding (MOU).
Collaborating Institutions	
IFDC Contract Number	01583/01
Budget Amount	Signed contract with ICRAF for $100,000 on October 29, 2001
Amendment(s)	Amendment 1 dated October 31, 2001, to Mr. Laksiri Abeysekera modified Articles 2.2.3 Payments and 2.2.4 Financial Reports. Amendment 2 dated September 27, 2002, to Mr. Laksiri Abeysekera modified Articles 1.0 Introduction and Statement of Work and 2.1 Effective Dates of the MOU.
Extension Ending Date	March 31, 2003

IFDC■01583 01

Memorandum of Understanding

Between

International Fertilizer Development Center
PO Box 2040
Muscle Shoals, AL 35662, USA

And

International Centre for Research in Agroforestry (ICRAF)
PO Box 30677
Nairobi, Kenya

October 1, 2001

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Memorandum of Understanding

Between

International Fertilizer Development Center
PO Box 2040
Muscle Shoals, AL 35662, USA

And

International Centre for Research in Agroforestry (ICRAF)
PO Box 30677
Nairobi, Kenya

The International Fertilizer Development Center (hereinafter referred to as IFDC) is a public international organization (PIO) dedicated to increasing sustainable agricultural production through the improved use of yield enhancing technologies. ICRAF has submitted a proposal to USAID to (1) document impacts of current land management practices and socioecopolitcal factors, and (2) support development of spatial tools to support soil and water conserving and local community development efforts, and (3) enhance African institutional capacity in the use of GIS/remote sensing and other geospatial decision support tools. In order to carryout the work described herein, IFDC and ICRAF hereby agree to the following terms and conditions:

1.0 INTRODUCTION AND STATEMENT OF WORK

The United States Agency for International Development (USAID) has entered into an Agreement with IFDC for IFDC to undertake a project entitled "Quick Start for Agriculture in Africa" to support the Geographic Information for Sustainable Development (GISD) project leading up to the World Summit on Sustainable Development (WSSD).

IFDC will provide USAID/EGAD/AFS with logistical and management support to the various partners involved in the implementation of the GISD project, including transferring and providing overall fiscal oversight to specific "pass-through" funds to selected partners who are being asked to implement specific GISD activities. This will include work already identified in

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specific proposals from the NRC, OGC, and several other groups located in the four Target Regions: Upper Niger Basin, African Great Lakes Region, the Kenya-Tanzania Coastal Zone, and the Limpopo/Zambeze River Basin Region of southern Africa.

IFDC will work in close collaboration with the technical officers within USAID providing oversight: Note: The Overall Coordinator is Robert E. Ford, AEMD – Agricultural Enterprise and Market Development Division within USAID's office of Agriculture and Food Security. Robert E. Ford is the Chair of the GISD-IWG for Regional Applications sub-group.

Close coordination must also occur with co-Chairs of the GISD-IWG for each sub-region. They are: Barbara Best (G/ENV) for the Kenya-Tanzania CZM Activity; Paul Bartel and Jon Anderson (AFR-SD) for the Four Corners/Limpopo/Zambezi Basin region; Robert Ford for the Great Lakes/Great Horn of Africa Region; and Mike McGahuey (USAID/AFR-SD).

ICRAF will (1) document impacts of current land management practices and socio-eco-political factors (Changes in biophysical parameters related to natural resource base condition and producer behavior, Delineate areas of conservation and development conflicts, Explain changes in terms of policy and institutional frameworks; (2) Develop spatial tools to support soil and water conserving and local community development efforts; and (3) Enhance African institutional capacity in the use of GIS/Remote Sensing and other geo-spatial decision support tools. A description of the activities to be undertaken by ICRAF, technical procedures to be followed, deliverables required, and estimated schedule are presented in Attachment 1, which is incorporated as an integral part of this Memorandum of Understanding (MOU).

2.0 SPECIFIC CONDITIONS

2.1 Effective Dates of MOU

The effective dates of this MOU are October 1, 2001-September 30, 2002.

2.2 Finance

The work to be performed under this MOU is being financed by USAID with all funds channeled to IFDC. IFDC shall provide funding to ICRAF in accordance with the terms and conditions described in this MOU. ICRAF may develop subagreements as necessary to support funding arrangements and the work to be performed by its collaborating institutions. The estimated funds available to ICRAF total US $100,000 (one hundred thousand) as follows:

Item	Total US $
Personnel	
Local	43,000
International	20,000
Databases, photos, images	5,000
Misc. Travel and Supplies	10,000
Administration	22,000
TOTAL	**100,000**

2.2.1 Use of Funds

IFDC has fiduciary responsibility of funds received from USAID. Under the terms of this MOU, all funds provided to ICRAF shall be utilized solely for the purposes indicated in the budget under 2.2. Said funds shall cover all expenditures necessary for the services to be performed by and/or arranged by ICRAF. IFDC shall not be responsible for any additional costs (i.e., above US $100,000) incurred in the performance of the work described under this MOU.

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2.2.2 Allowable Costs

(a) ICRAF shall be reimbursed for costs incurred in carrying out the purposes of this MOU, which are reasonable, allocable, and allowable.

(b) Reasonable shall mean those costs that do not exceed those which would be incurred by an ordinarily prudent person in the conduct of normal business.

(c) Allocable shall mean those costs that are necessary to the MOU.

(d) Allowable shall mean those costs which are reasonable and allocable, and which conform to any limitations set forth in this MOU.

(e) Prior to incurring a questionable or unique cost, ICRAF is encouraged to obtain IFDC's written determination as to whether the cost will be allowable.

2.2.3 Payments

IFDC shall make payments to ICRAF subject to the receipt of funds from USAID and based upon receipt of an official invoice from ICRAF. The invoice may be faxed to the official IFDC Business Contact indicated in 2.6.1. The payments shall be made on a monthly cost reimbursement basis based upon ICRAF'S submission of financial reports, which substantiate costs incurred in the performance of this MOU.

2.2.4 Financial Reports

ICRAF shall provide to IFDC, within 20 days of the end of each month under this program, a financial report indicating funds received from IFDC and funds expended under this MOU. The financial reports shall include accounting for all allowable costs incurred by ICRAF under the program in accordance with the line item budget amounts indicated in 2.2. Copies of documentation to support all costs incurred in performance of work described in this MOU.shall be sent to IFDC upon request by IFDC/USAID.

2.2.5 Audit

ICRAF shall maintain books, records, documents, and other evidence in accordance with ICRAF's usual accounting procedures to sufficiently substantiate charges to this MOU. IFDC and USAID reserve the right to examine and ICRAF agrees to make available all financial records and documents of ICRAF as related to this MOU. Any costs that are determined by either IFDC or USAID to be inconsistent with the terms and conditions of this MOU shall immediately be refunded to IFDC.

If ICRAF expends US$300,000 or more per their fiscal year in USAID awards, ICRAF shall have an annual audit conducted in accordance with the "Guidelines for Financial Audits Contracted by Foreign Recipients" issued by the USAID Inspector General. If ICRAF does not meet this expenditure threshold for USAID funds, they are exempt from the above audit requirement unless exempted from such audit by USAID.

A copy of the audit report (if required) will be submitted to IFDC's supervisor, Accounting Services, by ICRAF within thirty (30) days of completion of the audit.

2.2.6 Refunds

(a) There will be no advances under this MOU.

(b) Funds not disbursed to ICRAF at the time the MOU expires or is terminated shall revert to IFDC, except for such funds encumbered by ICRAF by a legally binding transaction applicable to this MOU. Any funds advanced to but not expended by ICRAF at the time of expiration or termination of the MOU shall be refunded to IFDC except for such funds encumbered by ICRAF by a legally binding transaction applicable to this MOU.

(c) If, at any time during the life of the MOU, or as a result of final audit, it is determined that funds provided under this MOU have been expended for

purposes not in accordance with the terms of this MOU, ICRAF shall refund such amount to IFDC.

2.3 Language

The MOU has been executed in English, which shall be the binding and controlling language for interpretation of the terms and conditions of this MOU.

2.4 Subagreements

It is understood that ICRAF may carryout the work described under this MOU in collaboration with others. It is further understood that funds provided to ICRAF may be used to support work carried out by collaborating institutions. ICRAF shall ensure that the specific conditions of this MOU (i.e., Section 2.0, Specific Conditions) shall apply to all such subagreements.

2.5 Revision of MOU Budget

(a) The approved MOU budget is the financial expression of ICRAF's program.

(b) ICRAF shall immediately request approval from IFDC when there is reason to believe that within the next 30 calendar days a revision of the approved MOU budget will be necessary for any of the following reasons:

- To change the scope or the objectives of the program and/or revise the funding allocated among objectives by more than ten percent of the total budget amount unless the schedule states otherwise.
- Additional funding is needed.
- ICRAF expects the amount of authorized funds to exceed its needs by more than $5,000 or five percent of the MOU budget, whichever is greater.

(c) Except as required by other provisions of this MOU specifically stated to be an exception from this provision, IFDC shall not be obligated to reimburse ICRAF for costs incurred in excess of the total amount obligated under the MOU. ICRAF shall not be obligated to continue performance under the MOU

(including actions under the "Termination Procedures" provision) or otherwise to incur costs in excess of the amount obligated under the MOU, unless and until IFDC has notified ICRAF in writing that such obligated amount has been increased and has specified the new MOU total amount.

2.6 Other Terms and Conditions

The following terms and conditions, which are applicable to the MOU by and between USAID and IFDC, shall be integral part of this Agreement.

2.6.1 Official Contacts

The contacts under this MOU for all official contacts are as follows:

IFDC Technical
Dr. Lawrence L. Hammond
Director, Research and Development Division
IFDC
PO Box 2040
Muscle Shoals, AL 35662, USA
Telephone: 256/381-6600, extension 270
FAX: 256/381-7408
lhammond@ifdc.org
www.ifdc.org

IFDC Business
Mr. John H. Allgood
Director, Finance, Administration, and Support Services
IFDC
PO Box 2040
Muscle Shoals, AL 35662, USA
Telephone: 256/381-6600, extension 211
FAX: 256/381-7408
jallgood@ifdc.org
www.ifdc.org

ICRAF Technical/Business
Dr. Robert Zomer
Landscape Ecologist and GIS Specialist
Natural Resource Problems
Priorities and Policies Programme of ICRAF
International Centre for Research in Agroforestry
PO Box 30677, Nairobi, Kenya
Telephone: +254 2 521450 or +1 650 833 6645
Fax: +254 2 521001 or +1 650 833 6646
ICRAF@cgiar.org

Dr. David Siriri
Acting ICRAF Coordinator for Kabale
USAID Project
International Centre for Research in Agroforestry
PO Box 30677, Nairobi, Kenya
Telephone: +254 2 521450 or +1 650 833 6645
Fax: +254 2 521001 or +1 650 833 6646
ICRAF@cgiar.org

2.6.2 Publications and Media Releases

If it is ICRAF's intention to identify USAID's contribution to any publication, video or other information/media product resulting from this MOU, ICRAF shall state that the views expressed by the author(s) do not necessarily reflect those of USAID. Acknowledgements should identify the sponsoring USAID Office and Bureau or Mission as well as USAID substantially as follows:

"This [publication, video or other information/media project (specific)] was made possible through support provided by the Center for Economic Growth and Agricultural Development, Office of Agriculture and Food Security, under the terms of the MOU. The opinions expressed herein are those of the author(s) and do not necessarily reflect the views of USAID."

ICRAF shall provide the relevant strategic objective or results package team with one copy of all published works developed under this MOU and with lists of other written work produced under the MOU.

Except as otherwise provided in the terms and conditions of the MOU, the author or ICRAF is free to copyright any books, publications, or other copyrightable materials developed in the course of or under this MOU, but USAID reserves a royalty-free nonexclusive and irrevocable right to reproduce, publish, or otherwise use, and to authorize others to use the work for U.S. Government purposes.

2.6.3 Reports and Data

ICRAF shall send to the IFDC Technical Contact at the address included in this MOU, monthly and quarterly progress reports in a form and substance satisfactory to IFDC. The monthly reports will provide a brief report on the status of activities being undertaken to implement this project during the previous 30 days.

The quarterly reports shall indicate progress toward achieving Program objectives and implementing approved work plans. The reports shall include, but not be limited to, the following information:

- Status of achievement of program goals, objectives, and benchmarks specified in the annual work plan
- Progress or completion of components, elements, or activities against planned targets
- Program description
- Other accomplishments or program highlights
- Identification and explanation of significant problems which have been encountered
- Description of planned corrective action

The monthly and quarterly reports may be submitted in electronic format and are to be delivered to IFDC within 7 calendar days and 20 calendar days, respectively, of the end of the reporting period. A final report addressing the same components included in the quarterly report is to be submitted to IFDC by ICRAF within

45 calendar days of the ending date of this MOU. The reports submitted to ICRAF to IFDC and supporting materials compiled in performing the services shall be the property of USAID.

ICRAF is also required to submit copies of reports/publications, produced within each activity as requested by the USAID Cognizant Technical Officer (e.g., workshop proceedings, PowerPoint presentations, etc.).

2.6.4 Termination

This agreement may be terminated, in whole or in part, by either party at any time upon 30 days written notice of termination. Upon receipt of and in accordance with a termination notice from the IFDC, the ICRAF shall take immediate action to cease all expenditures financed by this MOU and to cancel all unliquidated obligations if possible. Further, upon receipt of notice of termination, the ICRAF shall not enter into any further obligations under this MOU. Except as provided below, no further reimbursement shall be made after the effective date of termination. The ICRAF shall within 30 days of the effective date of termination repay to IFDC all unexpended funds that are not otherwise obligated by a legally binding transaction applicable to this MOU. Should the funds paid by IFDC to the ICRAF prior to the effective date of termination be insufficient to cover the ICRAF's obligations in a legally binding transaction, the ICRAF may submit to IFDC within 90 days after the effective date of termination a written claim for such amount. The IFDC shall determine the amount(s) to be paid by IFDC to the ICRAF under such claim in accordance with the "Allowable Costs" provision of this MOU.

2.6.5 Dispute Settlement

Because of the nature of this agreement and legal status of the respective organizations engaged under this MOU, reconciliation of disputes which cannot be handled amicably will be settled through discussions/negotiations by and between the signatories to the MOU.

2.6.6 Investment Promotions

No funds or other support provided hereunder may be used in a program or activity reasonably likely to involve the relocation or expansion outside of the United States of an enterprise located in the United States if non-US production in such relocation or expansion replaces some or all of the production of, and reduces the number of employees at, said enterprise in the United States.

No funds or other support provided hereunder may be used in a program or activity the purpose of which is the establishment or development in a foreign country of any export processing zone or designated area where the labor, environmental, tax, tariff, and safety laws of the country would not apply, without the prior written approval of IFDC.

No funds or other support provided hereunder may be used in an activity which contributes to the violation of internationally recognized rights of workers in the recipient country including those in any designated zone or area in that country. This provision must be included in all subagreements.

2.6.7 Non-Liability

IFDC does not assume liability for any third party claims for damages arising out of this MOU.

2.6.8 Notices

Any notice given by either party under this MOU shall be sufficient only if in writing and delivered in person or faxed to the official contact persons identified in 2.5.1

2.6.9 Special Provisions

ICRAF shall comply with USAID environmental regulations (22 CFR Section 216 "Regulation 16") with respect to the activities to be undertaken under this MOU.

2.6.10 Procurement Policies and Procedures

Because USAID is the sole contributor, USAID procurement policies and procedures are applicable (22 CFR Section 226 and ADS 308.5.7a).

2.6.11 Ineligible Countries

Activities under this agreement may only be carried out in countries that are eligible to receive assistance under the Foreign Assistance Act. ICRAF shall provide IFDC in advance a list of those countries where activities are planned under this MOU.

2.6.12 Entire MOU

Unless otherwise specified, this MOU embodies the entire understanding between IFDC and ICRAF for the services to be provided and any prior to contemporaneous representations, either oral or written, are hereby superseded. No amendments or changes to this MOU, including, without limitation, changes in the statement of work, total estimated cost, and period of performance, shall be

Attachment 1

Concept Note

Implementation of Geographic Information System to Support Sustainable Development: Improving Land Management and Policy-Making at the Local Community/Local Authority Level in Southwest Uganda

World Summit for Sustainable Development
October 2002

1. Objective

1.1 Document impacts of current land management practices and socio-eco-political factors
   a) changes in bio-physical parameters related to natural resource base condition and producer behavior,
   b) delineate areas of conservation and development conflicts
   c) explain changes in terms of policy and institutional frameworks;

1.2 Develop spatial tools to support soil and water conserving and local community development efforts.

1.3 Enhance African institutional capacity in the use of GIS/Remote Sensing and other geo-spatial decision support tools.

2. Overview

2.1 Geographic focus

The Kigezi highlands of SW Uganda are a component of an intensively cultivated "eco-region" found in East and Central Africa. The larger eco-region is referred to as the "bread basket" of this part of Africa. It provides 50% of the staple foods, strategic cash crops (such as tea and coffee) and contains about 50% of the population. These functions are under threat due to relatively high population pressure (100-200 people/km^2) and to non-conducive development policies. These have contributed to division of land into critically small, often fragmented farms (due to land inheritance practices) reaching 0.25 to 1.0 ha for an average family of six, and have resulted in high levels of poverty, given the inability to cope. Unsustainable land use intensification has resulted in a diminished natural resource base given the population's declining ability to: maintain and improve soil fertility and control erosion; successfully intensify livestock feed and nutrient management systems; maintain social cohesion and positive management arrangements in the face of changes in government and policies and increased competition for scarce resources. In addition, poor infrastructure exacerbates distance from markets, a low level of input supplies. Finally, there is limited credit and continued low local wage rates. The situation is worsened by the increase in HIV and the increased need for family labor to seek employment elsewhere. These change family structures and constrain labor inputs. Indicators of decline are: lower yields, more pests and diseases of poor intensification, declining income, fewer options for diversification, and reduced general ability to cope.

2.2 Prevailing research

Past research efforts throughout the ecoregion, have been relatively ineffective in dealing with the problems noted above because it has been largely non-participatory, has had limited links to development, has had slight impact on policy setting, and has limited understanding of or relevance to prevailing socio-economic factors of rural households.

2.3 Shifting the research paradigm

Current research supported by USAID and other donors, and working through organizations such as ICRAF and the African Highlands Initiative (AHI) is promoting a "farming-system", community-based approach. The R&D agenda is developed with farmer groups and community/district stakeholders with the objective of documenting experiences and "best practices" and then packaging these for application and dissemination by extension partners such as Africare and CARE. Further, there is now a concerted effort to improve the contribution of research to development by promoting applied, on-the-ground village and district level participation and implementation of a more informed agenda. Importantly, the approach attempts to build local capacity of community members, local authority district decision-makers, NGO partners and of researchers and their organizations.

3. Current Initiatives—the case of the Kabale, Uganda "benchmark site"

In 1995, NARO and other research partners chose Kabale as a "benchmark site" that exhibited the challenges facing research noted above and initiated a case study as part of shifting the research paradigm, while producing impact on the ground.

3.1 Method used to date (1996-2001)

- SW Uganda was initially divided into farming systems zones having indicative enterprise combinations, infrastructure and a biophysical endowment;
- "Wealth-ranking" style PRAs were conducted in two of the 5 zones to define the nature, extent and relationships of production constraints from the viewpoints of household economic stratification (wealthy, middle and poor) categories of farmers;
- Intensive study of land use change in two catchment areas - 1950 vs 1990 comparison;
- Findings shared with farmers and with a wider group of stakeholders (district government, NGOs, research organizations) to reveal and refine the cause-effect analyses and relationships;
- Developed participatory action plan for the district focusing on options and approaches for 1) improving soil fertility and soil and water conservation; 2) improving sustainable diversification and intensification of cropping systems including better pest and disease management 3) supporting the evolution of a policy working group; and 4) improving communication and information flow.
- Various organizations contributed their expertise; developed further projects; and relate through a voluntary coordinating committee chaired by ICRAF/NARO
- Use of farmer groups (often self-established) for community level work and discussions. Social capital aspects targeted as key area of research and intervention.

3.2 Research and development focus: 1996-2001
Examples of multi-institutional efforts to date:

3.2.1 Agroforestry technologies selected and scrutinized in on-farm testing: various species selected for improving soil fertility using improved fallows, biomass transfer and in-situ; degraded areas reallocated to wood and pole production; fodder tree species incorporated into hedgerows and along conservation boundaries; fruit trees introduced and now being spread byl NGOs and extension (AFRENA-NARO-ICRAF/Africare)

3.2.2 IPM of potato wilt and developing a "package" of clean potato seed production, cultural techniques (rouging, rotations, hilling and clean seed) to reduce disease spread, and improved varieties (CIP, Africare, CARE and NARO); built & enhanced farmer capacity to use these practices. Now being spread by NGOs and extension. IPM and integrated approaches of soil fertility and water and soil management to address nematodes and weevils on bananas (IITA and NARO). This led to a large number of potato seed producing groups linked to a number of development organizations. Subsequently, there was a study of local potato seed producing groups to understand how individual organizations could be better integrated and/or managed to achieve larger impact (AHI, CIP, PRAPACE and NARO).

3.2.3 Soil nutrient flow and depletion studies to document and quantify losses from farm, community and district levels followed by enhanced soil fertility measures that integrate legumes and inorganic inputs. Included establishment of farmer credit groups focused on saving and leveraging supplies of inorganic fertilizer (1998, Makerere University, TSBF, CARE, NARO, AFRENA, CIAT).

3.2.4 As part of the IPM, improved soil management and diversification efforts, more than 25 farmer groups under the direct auspices of AHI, and many more were involved undertake participatory, farmer-led adaptive research activities in soil fertility, and farming system intensification and diversification (wheat - NARO and CIMMYT); climbing bean and root rot resistant bean (NARO, ECABREN and CIAT); sorghum and maize (NARO), potato and bean seed systems (NARO and CIP), tree species (AFRENA-NARO-ICRAF). Initiatives mostly located in Rubaya and Kashambya sub-counties, over-lain with a sociological study to identify features that sustain and maintain farmer groups (CIAT Participatory Research and Gender Analysis System-wide program).

3.2.5 Established experimental Telecentre in Kabale town and in Rubaya sub-county with a satellite node also in Katchwekano Kabale (NARO's ARDC). The purpose is to enhance communication between the rural and service sectors, distribute market information. Telecentre serves as a focal point for literacy classes, field demonstrations, etc. and is managed as a private enterprise.

3.2.6 Initiated a policy working group composed of local government, NGOs and research organizations (*e.g.*, ICRAF, CIAT). Focus is on building local capacity to analyze by-laws, and promote compliance. *GIS spatial analyses required to enhance decision-making.* Current focus is catchment level, want to "scale up" to district level.

Preliminary GIS activities within SW Uganda are currently being initiated by ICRAF-AFRENA and AHI. These activities are being undertaken, with technical support and training from ICRAF- HQ in Nairobi, to address a variety of pressing natural resource and community development issues.

4. Enhancing Agriculture-NRM Linkages and Policy-Making through expanded use of Geo-Spatial "Tools"

Geo-spatial analyses would add value to current and future USAID and other donor support to research, development, extension and community applications in Kabale. Existing spatial data is largely unassembled or has gaps for district (meso)-scale characterization and spatial analysis as well as at watershed (micro) scale. There is little spatial data available in a form that can be used to influence decision making at community and district levels. The following activities and related products would add value as follows:

Objective 1: Document impacts of current land management practices and understand associated socio-economic and political factors

a) changes in bio-physical parameters related to natural resource base condition and producer behavior,
b) delineate areas of conservation and development conflicts
c) explain changes in terms of policy and institutional frameworks;

Activities:

1.1) Multi-scale characterization of land use and identification of poverty and natural resource management problem domains.

A comprehensive multi-layer GIS database will be developed for seven districts in SW Uganda, at various scales. Available databases (including the Uganda National Biomass Survey data, and other available datasets) will be combined with data collected in the field, and analysis of a variety of remote sensing data. Data to be collected will include both biophysical attributes of landscapes and socio-economic and cultural criteria necessary to evaluate production systems. Data which can be used to parameterize a variety of modeling activities will be compiled at landscape, watershed, catchment, and micro-catchment scales. This database will provide the basis for characterization of landuse and landcover, and identification and delineation of both current and potential NRM problem domains. The results will assist in and improve decision making, cause - effect analysis, priority setting at community, catchment and district levels enhancing the dialogue sessions currently being implemented as part of the social capital and land use analysis work. Generally, this would provide a spatial dimension, currently lacking, looking at current and future scenarios and impact of different policies and decisions. The analysis could help build up a relationship between the micro-watershed process and the district decision making / policy and development process.

1.2) Delineation of potential conservation / development conflicts.

Southwest Uganda contains an abundance of globally significant biodiversity, both flora and fauna. A GIS-based spatial modeling approach will be used to identify the spatial dimension of potential conservation / development conflicts, and delineate their spatial

extent. Important areas of investigation include a wetlands delineation and use survey, and analysis of buffer zone conservation strategies, notably around Bwindi Impenetrable National Forests and other high priority conservation areas.

Objective 2: Develop spatial tools to support soil and water conserving and local community development efforts.

Activities:

2.1 Tools to support hillside management and soil and water conservation efforts.

GIS-based spatial tools will be developed to support the evaluation of current and proposed hillside management strategies. On-site measurements, remote sensing data, and GIS- based spatial modeling will be integrated to develop an erosion hazard index at the landscape scale, as well as for several test watersheds and catchments. These tools will be used to outline and evaluate a series of future scenarios, based on alternative strategies, to guide both communities, and other local decision and policy makers, to adopt appropriate and cost-effective hillside management strategies.

2.2 Development of spatial tools to support activities local community development efforts.

Tools and analyses will be developed to utilize the comprehensive GIS database to support local community development efforts, at a variety of scales. Efforts within this activity focus will include analyses on marketing, infrastructure, and effectiveness of development outreach efforts. This spatial analysis will enhance ongoing community-level discussions concerning current land use practices & their impact over time (derived from looking at change over time from spatial data). It could also identify trouble spots & look into causalities. Given this information, communities can also put their own information in the database (adding in ITK), e.g. field history, soil information, etc. so it becomes theirs. This information can also look into scenarios for future management (using modeling) that can help look at what could be done where. This would lead to community action plans (perhaps fine-tuning the PEAPs, etc.). Further, by looking at spatial aspects of infrastructure and markets, the economic side of the picture can be developed. We know that by increasing income, people can invest more in their land care.

3.3 Development of tools to support targeting of agroforestry and other interventions and to understand the impact of various technologies.

Spatial analysis and modeling of natural resource domains will be used to identify potential areas where the introduction of particular agroforestry technologies, or other NRM interventions, can have maximum effectiveness to address specific NRM problems or local poverty. For example, areas where agroforestry can benefit soil and water conservation will be selected using criteria like slope steepness, vegetation ground cover, or soil type. Areas potentially benefiting from increase on-farm diversity could be selected using land cover analysis and proximity to conservation areas. Sites for intensification of production will be selected using criteria like population densities, poverty indices, biophysical potential, and access to markets. Additionally, GIS tools

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can be used as a basis for stratified site or household selection for surveys, on farm trials or scaling up activities. Knowing where projects have been successful, or where particular species do best, the GIS database can be used to delineate the optimal extrapolation domains for dissemination and outreach. Additionally, other critical factors, e.g. distance to market, transportation costs, local or regional demand, will be modeled. Other important agroforestry specific analyses can include estimates of the potential number of trees that can be accommodated in a particular area for a particular purpose. Such information is particularly useful for development NGOs and government departments in their planning process.

These analyses will also include the analysis of potential and real impact of agroforestry and other selected improved on-farm NRM interventions on watershed condition by tracking changes in watershed hydrological functions (flow rates, storm intensity).

Objective 3: Enhance African institutional capacity in the use of GIS/Remote Sensing and other geo-spatial decision support tools.
Capacity building would be an integral part of the above activities. ICRAF's GIS lab at headquarters is set up for training nationals. The tools would be developed using a participatory approach, which would enhance the contribution and usefulness of the tools, and train local users in their application. Data collection and analysis would involve local expertise, and capacity building would be part of this activity.

5. Institutional Partners

5.1. ICRAF as implementing agency

ICRAF is well placed to do the work under discussion, has expertise in geospatial studies and has models that could be adjusted to fit Kabale. They have expertise is doing livelihood analysis as well as impact studies. Their specific interest and expertise is in agroforestry and targeting its use and its impact. ICRAF and the Forestry Research Institute (a component of the National Agricultural Research Organization) has been working in the Kabale area for over ten years.

Beyond the geospatial work which is being discussed here, AHI, also handled by ICRAF, is interested in broadening the technical interventions - including agroforestry trees but also other options (herbaceous legumes for fodder, for example). As a consortium of research organizations, its partners are already contributing other interventions and increasing the a number possible solutions and expertise. AHI promotes the use of an integrated approach (inclusive of policy, economics, social dimensions as well as technical components) towards solving land degradation and associated poverty issues regionally. ICRAF is a strong contributer to this effort.

Specifically in Kabale, the work proposed would add value to existing (and potentially future efforts) funded by USAID and others: ongoing work with a local policy task force that is revising by-laws through community efforts (CIAT-ICRAF-NRI); the Agroforestry Buffer Zone project (ICRAF-NARO), NARO adaptive technology development (one source of agroforestry and other technical options); soil fertility research and options (Makerere & TSBF & ICRAF), among others.

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effective unless made in writing and signed by authorized representatives of the parties.

FOR AND ON BEHALF OF IFDC

By: _____

Name: LAWRENCE HAMMOND

Title: DIRECTOR, RDD

Date: 10-29-01

FOR AND ON BEHALF OF ICRAF

By: _____

Name: TIFFIN D. HARRIS

Title: DIRECTOR, MANAGEMENT SERVICES

Date: 29/10/01

WITNESS:

By: _____

Name: DAN WATERMAN

Title: DEVELOPMENT OFFICER

Date: 10/29/01

WITNESS:

By: _____

Name: GLENN L. DENNING

Title: DIRECTOR, DEVELOPMENT

Date: 29/10/01

Engaged in Kabale (USAID support for agroforestry technologies' use, adoption and impact).

5.2 Specific linkages regarding spatial research

In addition to adding value to ongoing efforts mentioned, the activities described here for southwest Uganda will be linked to complementary spatial analysis now being conducted by IFPRI under contract to the USAID mission in Uganda. It will also be linked to ICRAF's project on "improved land management in the Lake Victoria Basin" through which various new research methods have been developed. In addition, it will link to an ILRI-led project on land use and land cover change in East Africa (LUCID). Southwest Uganda is one of the case study areas for the LUCID project.

5.3 Personnel Involved

Lead scientists:

1. Dr Robert Zomer, Landscape ecologist and GIS specialist, Natural Resource Problems, Priorities and Policies Programme of ICRAF, Nairobi, Kenya (American)
2. Mr David Siriri - acting ICRAF coordinator for Kabale USAID project (Ugandan)

Contributing scientists:

1. Dr Frank Place, Senior Economist, Natural Resource Problems, Priorities and Policies Programme of ICRAF, Nairobi, Kenya (American)
2. Dr. Ann Stroud, AHI Regional Coordinator, Kampala, Uganda (American)
3. Dr Jean-Marc Boffa, Tree Domestication Specialist, Kifu, Uganda (French)
4. Dr. Brent Swallow, Principal Economist and Leader of the Natural Resource Problems, Priorities and Policies Programme of ICRAF, Nairobi, Kenya (Canadian)

5.4 Partners/match ("leveraging")

1. Department of State (travel)
2. Industry/private sector (equipment & materials)
3. NASA to donate LANDSAT-7 & SRTM (DEMS) imagery/analyses
   * land use change around the border of forested areas and interactions with agriculture)

6. Budget

Indicative budget depends upon the length of time for the grant and the level of the actual available budget (1 year budget provided). Estimates given with assumption that partners matching contributions are provided, so are not included here. If not, budget would have to increase. Total: $100,000

Personnel costs	
Local	$43,000
International	$20,000
Databases, photos and images	$ 5,000
Local travel	$10,000
Administrative costs	$22,000

IFDC INTERNATIONAL FERTILIZER DEVELOPMENT CENTER • MUSCLE SHOALS ALABAMA 35662 USA
P.O. BOX 2040 • 256-381-6600
EMAIL-general@IFDC.org
TELEFAX NO. 256-381-7408

October 31, 2001

Mr. Laksiri Abeysekera
International Centre for Research in Agroforestry (ICRAF)
PO Box 30677
Nairobi
KENYA

Dear Mr. Abeysekera:

Amendment Number 1 to MOU between the International Fertilizer Development Center (IFDC) and the International Centre for Research in Agroforestry (ICRAF)

This letter shall serve as Amendment Number 1 to the Memorandum of Understanding between IFDC and ICRAF to support the Geographic Information for Sustainable Development (GISD) project. The parties to the MOU agree that articles **2.2.3 Payments** and **2.2.4 Financial Reports** will be deleted from the MOU and the following inserted in place thereof:

2.2.3 Payments
IFDC shall make payments to ICRAF subject to receipt of funds from USAID and based upon receipt of an official invoice from ICRAF. The invoice may be faxed to the official IFDC Business Contact indicated in 2.6.1. The initial payment shall be made on a quarterly basis in advance based upon the projected expenses for the first quarter. Subsequent advances shall be on a quarterly basis based upon receipt by IFDC of a financial statement to liquidate the advance and a projection of the next quarter's expenses.

2.2.4 Financial Reports
ICRAF shall provide IFDC, within 60 days of the end of each quarter, a financial report indicating funds received from IFDC and funds expended under this MOU. The financial reports shall include accounting for all allowable costs incurred by ICRAF under the program in accordance with the line item budget amounts indicated in 2.2. Copies of documentation to support all costs incurred in the performance of the work described in this MOU shall be sent to IFDC upon request by IFDC USAID.

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Mr. Laksiri Abeysekera
October 31, 2001

All other terms and conditions of the MOU by and between IFDC and ICRAF shall remain in full force and effect.

Sincerely yours,

Amit H. Roy
President and Chief Executive Officer

ACCEPTED AND AGREED TO:

5/12/01

International Centre for Research in Agroforestry (ICRAF)

IFDC INTERNATIONAL FERTILIZER DEVELOPMENT CENTER • MUSCLE SHOALS ALABAMA 35662 USA
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TELEFAX NO. 256-381-7408

September 27, 2002

Mr. Laksiri Abeysekera
International Centre for Research in Agroforestry (ICRAF)
PO Box 30677
Nairobi
KENYA

Dear Mr. Abeysekera:

Amendment Number 2 to MOU between the International Fertilizer Development Center (IFDC) and the International Centre for Research in Agroforestry (ICRAF)

This letter shall serve as Amendment Number 2 to the Memorandum of Understanding between IFDC and ICRAF to support the Geographic Information for Sustainable Development (GISD) project. The parties to the MOU agree that articles **1.0 Introduction and Statement of Work** and **2.1 Effective Date of the MOU** are hereby changed as follows:

1.0 Introduction and Statement of Work
The statement of work under this MOU is hereby modified to include the work described in the letter dated August 26, 2002, from Dr. Zomer to Dr. Larry H. Hammond attached hereto as Attachment 1. The original scope of work referenced as annex 1 in the MOU by and between IFDC and ICRAF shall remain in full force and effect and is being supplemented by the additional tasks and activities indicated in Attachment 1.

2.1 Effective Date of the MOU
The effective dates of this MOU are October 1, 2001 – March 31, 2003.

All other terms and conditions of the MOU by and between IFDC and ICRAF shall remain in full force and effect. If you concur, please return one signed copy to IFDC for our records.

Sincerely yours,

John Allgood for Amit H. Roy

Amit H. Roy
President and Chief Executive Officer

ACCEPTED AND AGREED TO:

INTERNATIONAL CENTRE ICRAF FOR RESEARCH IN AGROFORESTRY

LAKSIRI ABEYSEKERA
International Centre for Research in Agroforestry (ICRAF)

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Attachment 1

World Agroforestry Centre

TRANSFORMING LIVES AND LANDSCAPES

Robert Zomer (I'm PI, but maybe this letter should be from someone else)...
Landscape Ecologist
International Center for Research in Agroforestry
Nairobi, Kenya

Lawrence L. Hammond
Director, Research & Development Division
International Fertilizer Development Center (IFDC)
P.O. Box 2040
Muscle Shoals, AL 35662
Tel: (256) 381-6600 ext. 270
Fax: (256) 381-7408

Date: August 26, 2002

RE: Six month no-cost extenstion for USAID GISD Project in SW Uganda

Dear Dr. Hammond

After consultation with the ICRAF Finance Unit, and other members of our SW Uganda GISD team, we have to decided to apply to IFDC (i.e. USAID) for a six month no-cost extension of our project. We have made substantial progress and achieved good results since the inception of this project, however we have a work plan, and sufficient funds left in our budget, that will take us through to March 2003. Therefore we request that the remaining funds continue to be disbursed to us, with a final completion date of March 31st, 2003.

In general, we will have met most of our original objectives and expected outputs by the original completion date of Sept 31st, however an enlargement of our goals to include the development of a Spatial Data Users Consortium has lengthened the timeline for implementation of this project. Below I summarize our objectives and expected outputs, progress to date, reasons why we can't fully deliver all expected outputs by September 31st, and the additional outputs that will be generated during the extension period.

a.) Objectives:

a. Document impacts of current land management practices and understand associated socio-economic factors

b. Develop spatial tools to support soil and water conservation and local community development efforts

c. Enhance institutional capacity in the use of GIS Remote Sensing and other geospatial decision support tools

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United Nations Avenue, Gigiri, PO Box 30677-00100 Nairobi, Kenya. Ph: 254 2 524000 or 1 650 833 6646
Fax: 254 2 524001 or 1 650 833 6646 | Email: icraf@cgiar.org, http: www.worldagroforestrycentre.org

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b.) Expected Outputs and Progress to Date:

a. Landuse and Cover Change Analysis for Three Districts in SW Uganda
   i. Expected completion by Sept. 31st
b. Mapping of Agricultural and Landuse System in Three Districts in SW Uganda
   i. Expected completion by Sept. 31st
c. Development of a Comprehensive GIS Baseline Database for SW Uganda incorporating all available datasets
   i. First iteration completed
   ii. Distribution will be through a series of workshops between now and March 31st, 2003
   iii. A prototype map server is up and running, and is being exhibited at WSSD by the OpenGIS Consortium.
d. Watershed management study supported by GIS Database
   i. High resolution DEM generated from topographic contours
   ii. NASA SRTM for test site incorporated into GIS database. A comparative analysis of accuracy and usability will be completed by September 31st.
e. A muli-media CD-Rom project describing Integrated Watershed Management Activities within the ICRAF study sites in SW, following a protocol of the CGIAR Global Mountain Program has been completed and will ready for distribution after review and editing.
f. Development of the Spatial Data Users Consortium, and construction of an information system that will integrate spatial and thematic data for land resource planning, and integrates local and regional level information.
   i. A stakeholder workshop was held in Kabale with the members of the Development Cosortium (and other interested participants) to facilitate the design and implementation of the GIS database. Modalities for data sharing and disemmination of the database will were decided upon.
   ii. A series of information and training workshops have been planned for each of the seven districts, to be held between now and March 31st.
   iii. The first iteration of the GIS database will be distributed between now and October 31st, through the training workshops
   iv. A second updated iteration of the database will incorporate data supplied by the Spatial Data Users Consortium members between now and November 31st. This updated iteration of the database will then be distributed to members of the consortium by March 31st.
   v. A Powerpoint presentation on the Spatial Data Users Consortium has be developed and supplied to ESRI for exhibition as WSSD.
   vi. A Poster presentation of the SW Uganda Project, including the Spatial Data Users Consortium concept, was put together and submitted to ESRI for display at WSSD.

g. Additional georeferenced data is in the process of collection, including GPS surveys to map important data currently not available, e.g. locations of various types of markets, health posts, agricultural input distribution centers, tree nurseries, water resources and other important infrastructure. This activity will continue through March 31st.
h. On-going GISD support to other on-going ICRAF research in SW Uganda:
    i. Tree Germplasm Production and Distribution
        1. Map of Natural Potential Vegetation digitized
        2. GIS database to form basis for analysis
    ii. Community Resource Mapping
        1. Exercise to be completed by March 31st.
    iii. Targeting of Agroforestry Technologies
        1. On-going activity
        2. Initial results for several tree species
    iv. Estimating Tree Seedling Requirements
        1. On-going activity
        2. Initial results for Kabale District

c.) <u>Necessity for extension of project to September 31st, and the additional outputs that will be generated during the extension period.</u>

a. A "Spatial Data User Consortium" concept was developed as part of the stakeholder workshop held in Kabale District in the first phase of this project. This long-term initiative requires the building of a network of users through a series of workshops. In March 2002, Beatrice Nabwire was hired to build up the Kabale ICRAF GIS Support Node, and to facilite the development of the consortium through a series of information and training workshops. It was decided to wait until the first iteration of the GIS database was complete before initiating training activities, so that a completed version of the database could be used in the training and distributed at that time. Since the project area covers seven districts, the logistics and travel time require a substantial lead up for the planning of the workshops.
b. Additional outputs not included in the original ICRAF GISD proposal include the establishment of an on-going and integrated information sharing network of spatial data users, and a series of training workshops. It is hoped that additional funding can be identified for this effort during the interim extension period, so that it will be able to continue to be supported beyond the March 31st completion target date.

Please contact myself, Brent Swallow (Program Leader), or Laksiri Abeysekera (ICRAF Finance Director) if this matters needs further discussion.

Thank you.... Robert Zomer

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PROJECT DATA SHEET

PROJECT NAME: Subcontract - ICRAF for GISD Project	CONTRACT NUMBER: IFDC Contract #: 01583/01 A3 Donor's #:	COUNTRY: AFRICA
FUNDING AGENCY/CLIENT: Subcontractor: ICRAF Prime: IFDC/USAID	CONTRACT AMOUNT: $100,000 Initial Obligated Amt:	PAYMENT METHOD: L/C ☐ Check ☒ Direct Deposit ☐ Payable by IFDC
START DATE (month/year): October 1, 2001	COMPLETION DATE (month/year): March 31, 2003	AMENDMENT NUMBER (if any): A3
TECHNICAL REPRESENTATIVE OF FUNDING AGENCY Name: Dr. Robert Zomer Address:PO Box 30677-00100 Nairobi KENYA Phone: 254 2 521450 Fax: 254 2 5210001 Email: icraf@cgiar.org	CONTRACT OFFICER/GRANT OFFICER Name: Mr. Laksiri Abeysekera Email: www.worldagroforestrycentre.org	IFDC DIVISION RESPONSIBLE FOR TECHNICAL REPORT MDD ☐ RDD ☒ IFDC/AFRICA ☐

OBJECTIVE:

PROJECT DESCRIPTION:

TECHNICAL DELIVERABLES

Report Type:	Frequency:	Due Dates:	Responsible IFDC Staff:
1.Progress Report	1.Monthly	1.Within 7 days	L. Hammond
2.Progress Report	2.Quarterly	2.Within 20 days	
3.Final Report	3.one	3.Within 45 days	
4.	4.	4.	
5.	5.	5.	

FINANCIAL DELIVERABLES

Report Type:	Frequency:	Due Dates:	Responsible IFDC Staff:
1.Invoices	1.Monthly	1.	D. Shedd
2.Financial Report	2.Monthly	2.Within 20 days	
3.	3.	3.	
4.	4.	4.	
5.	5.	5.	

OTHER DELIVERABLES

Report Type:	Frequency:	Due Dates:	Responsible IFDC Staff:
1.	1.	1.	
2.	2.	2.	

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January 20, 2003

Mr. Laksiri Abeysekera
International Centre for Research in Agroforestry (ICRAF)
PO Box 30677
Nairobi
KENYA

Dear Mr. Abeysekera:

Amendment Number 3 to MOU between the International Fertilizer Development Center (IFDC) and the International Centre for Research in Agroforestry (ICRAF)

This letter shall serve as Amendment Number ~~2~~ 3 to the Memorandum of Understanding between IFDC and ICRAF to support the Geographic Information for Sustainable Development (GISD) project. The parties to the MOU agree that article **2.2 Finance** is hereby changed as follows:

2.2 Finance

The work to be performed under this MOU is being financed by USAID with all funds channeled to IFDC. IFDC shall provide funding to ICRAF in accordance with the terms and conditions described in this MOU. ICRAF may develop subagreements as necessary to support funding arrangements and the work to be performed by its collaborating institutions. The estimated funds available to ICRAF total US $100,000 (one hundred thousand) as follows:

Item	Total US $
Personnel	
Local	21,000
International	17,720
Databases, photos, images	10,650
Misc. Travel and Supplies	28,630
Administration	22,000
TOTAL	**100,000**

Mr. Laksiri Abeysekera
January 20, 2003

All other terms and conditions of the MOU by and between IFDC and ICRAF shall remain in full force and effect. If you concur, please return one signed copy to IFDC for our records.

Sincerely yours,

Amit H. Roy
President and Chief Executive Officer

ACCEPTED AND AGREED TO:

(project leader Nambi)

International Centre for Research in Agroforestry (ICRAF)
EJA SOINI

USAID Supported GISSD Project in SW Uganda (2002-2003)

Final report

Implementation of Geographic Information Systems to support Sustainable Development: Improving land management and policy making at local community level in SW Uganda

Objectives of the project

- To document impacts of current land management practices and socio-eco-political factors
  - Changes in biophysical parameters related to natural resource base condition and producer behavior
  - Delineate areas of conservation and development conflicts
  - Explain changes in terms of policy and institutional frameworks
- To develop spatial tools to support water and soil conserving and local community development efforts
- To enhance African institutional capacity in the use of GIS/Remote sensing ad other geo-spatial decision support tools

The following were the achievements in the GISSD project (2002-2003)

- A workshop was held from 27th –28th February 2002 in Kabale. During the workshop, working groups comprised of representatives from NGOs and district administration staffs were formed, to identify GIS data/ information needs in relation to their organizations' activities, and also state the information products that could be provided/ contributed by their organizations towards the establishment of a GIS database for SW Uganda. The objectives of the workshop were in the context of the world summit on sustainable development – WSSD (held in South Africa, Sept 2002), GIS initiative in SW Uganda and were among others:
    - To provide an overview of the possibilities and applications provided by GIS and Remote sensing tools as well as to inform and involve stakeholders in ongoing efforts to build a GIS database for SW Uganda in order to improve Natural Resource Management
    - To solicit input and feedback from stakeholders to increase the relevance and usefulness of this database
    - To assess data needs, data availability and additional research or mapping required to implement a useful GIS for Natural Resource Management
    - To discuss mechanisms and modalities through which development partners can access and use GIS/RS services in SW Uganda
    - To explore potential modes of distribution, dissemination, training, and capacity building which will make the GIS useful to a variety of users

- A GIS workstation was established at FORRI office, Kabale. Some hardware and GIS software were acquired and a GIS resource person engaged.

- A GIS data users' consortium for SW Uganda was formed and includes many Natural Resource Management stakeholders. Data and information exchange and sharing was greatly enhanced notably with partners like AFRICARE, CARE, AHI, and some local leaders.

- A district lead focal agency/person for networking with the GIS project in each of the seven target districts (Bushenyi, Kabale, Kanungu, Kasese, kisoro, Ntungamo, and Rukungiri) was identified. This person is responsible for:
    - Linking up with local stakeholders who can potentially benefit and contribute to GIS
    - Maintaining contacts with the ICRAF-FORRI office
    - Facilitating the supply of information to build the database (data and organizations)
    - Inventorying computer resources available at the district level
    - Inventorying GIS users in the district

- Collection and compilation (in MS ACCESS format) of thematic data from all the seven target districts to enhance the local GIS database was completed. The district contact persons for each district facilitated in this data collection by investigating/exploring data availability and identifying the data sources. The table below indicates some of the data that was collected from each district:

District	Data collected
Kabale	NGOs, crop data, livestock numbers, Water sources, Road network, population figures
Kisoro	NGOs & CBOs, crop data, livestock numbers, Water sources, Road network, population figures, market centers
Kanungu	NGOs & CBOs, crop data, livestock numbers, Water sources, Road network, population figures, market centers
Rukungiri	NGOs & CBOs, crop data, livestock numbers, Water sources, Road network, population figures, market centers
Kasese	Crop data, livestock numbers, Water sources, Road network, population figures, market centers
Bushenyi	NGOs & CBOs, crop data, livestock numbers, Water sources, Road network, population figures, market centers

Ntungamo	NGOs & CBOs, crop data, livestock numbers, Water sources, Road network, population figures, market centers

- Some of this data was acquired in analog or statistical form and transformed into GIS compatible format e.g. a detailed coded road map of Kabale district and Kasese rainfall map,NGOs working in Kabale, Kisoro and Ntungamo, etc.

- GIS was used in various project activities for example to locate and map out:
    - Parishes where a diagnostic tree seed survey was carried out (by research students from the University of Norway).
    - Nursery locations in Kabale district
    - Organizations dealing with Natural resource management in Kabale, Kisoro and Ntungamo districts
    - Landscape restoration activities e.g. to characterize Rutenga hill slope, Kabale.
    - Delineation of watersheds for project activities e.g Katagata, Noozi, in Kabale, Nyakishenyi in Rukungiri, etc. This watershed delineation was also done for partners-AFRICARE for their food security activities.

- Two research projects by students from the Institute of Natural Resources of Makerere University were carried out.
    - Nahya Nkinzi conducted a study on Mapping land use/cover change in Kabale
    - Paul Baguma conducted a study on mapping land use and farm types in the four catchments areas of (Muko, Katagata, Nyakishenyi and Bukinda.

(See individual reports from these students)

- Two GIS training/awareness workshops were conducted in Kabale (between 18th –22nd November 2002 and 16th –20th December 2002). In these workshops, a total of 26 persons were selected from government and NGOs within the seven target districts. Participants and organizations considered were those that are actively involved in Natural Resource management in their districts. These were trained and

sensitized on the basic GIS functionality, usefulness and its various applications in Natural resource management. The objectives of the training were to:

- Build capacity for the target districts through training in basic GIS functionality and usefulness
- Train on data and information gathering to contribute to the existing SW Uganda Database
- Create awareness on the available GIS data layers for SW Uganda
- To distribute/disseminate GIS data for SW Uganda compiled on a data CD.

The following table shows the participants and their organizations:

District	Organization/Officer	Number of participants
Kabale	Care	1
	Africa 2000 Network	1
	AHI	2
	Africare	2
	ICRAF staff	2
Ntungamo	District Environment officer	1
	District Forestry officer	1
	ADRA	1
Kisoro	Water officer	1
	MBIFCT	1
	KDF	1
Kasese	District Agriculture officer	1
	Catholic Relief Services	1
	South Rwenzori diocese	1
Bushenyi	District Environmental officer	1
	District Farmers Association	1
	Rural Agric. Support Services	1
Rukungiri	District Environmental officer	1
	Farmers Association (RUDIFA)	1
	Gender Association (RUGADA)	1
Kanungu	District Agriculture officer	1
	COBS	1
	ITFC	1

- SW Uganda GIS Data layers (in ARCVIEW shapefiles format) compiled on a CD were distributed to the participants at the end of the training workshops together with Adobe Acrobat reader and ArcExplore software for accessing, exploring and viewing the data.

- As a follow up of the GIS training workshops held in Nov-Dec 2002, some of the district technicians and staff from organizations that were previously trained in the use of geo-spatial tools were provided with ARCVIEW GIS 3.2a software (This was installed on to their computers). The technicians were expected to use the software to explore the GIS data that was disseminated to them, make us of this data by doing analysis, editing and updating where required in their organizational activities. Below are the departments and organizations in the districts that were provided with the software

District	Department/Organization
Kabale	AHI, Africa 2000 Network, Care FIP, Africare
Rukungiri	Environment, Farmers' Association (RUDIFA)
Bushenyi	Environment
Kasese	Environment, South Rwenzori Diocese
Ntungamo	Environment, ADRA

The two districts of Kisoro and Kanungu did not have their computers ready for the installation of the software.

- One GIS training/awareness workshop was conducted for ICRAF-Agro forestry technical staff (Kabale site) from 19th –23rd March 2003. A total of 10 staff were sensitized and trained on basic GIS and RS functionality, usefulness and various applications of these geo-spatial tools in Natural resource management. The objectives of this training were to:
    - Build capacity for the Agro forestry technical staff in basic GIS and RS functionality and usefulness
    - Train on GIS data and information gathering

- Create awareness on available GIS datasets that could be made use of in the organization's natural resource management activities

At the end of the workshop the staff acknowledged the importance of the training and indicated that it would be very useful in their day-to-day activities in Natural Resource Management. They requested for further training in these tools.

- The development and assembling of a dynamic/interactive GIS data CD package (using Dynamic Knowledge Warebase/Maps) for SW Uganda together with making it accessible on to the stakeholders through the Internet was accomplished in ICRAF-Nairobi and is important as far as building institutional capacity in the use of Geo-spatial tools.

- With the help and guidance of some ICRAF-Agro forestry staff and GIS resource person, community/territorial/village maps were drawn by farmers form 10 communities in Ihanga watershed (Kabale district) and 1 community from Nyakishenyi (Rukungiri district). On these maps the farmers indicated the location of various resources including infrastructure, soil types (in local language), slopes, soil erosion and water run-off areas, settlements, etc. These maps were then modified in a GIS, drawn to scale and enlarged (printed on A1"- size) and returned back to the owner communities. The communities are expected to use them as geo-spatial planning support tools in Natural Resource Management activities in their villages.

Problems encountered

- The district contact persons selected for collaborating with the project and the districts always had busy official schedules, which always made networking (meetings and data collection) a bit difficult.
- Lengthy time taken to complete the GIS data CD that was compiled in Nairobi affected the pace of some outreach activities of the project like GIS data dissemination and GIS training workshops for stakeholders/designated technicians. However, these were accomplished all the same.
- Technical problems associated with the installation of Dynamic Knowledge software affected the original plan that the data be distributed and viewed principally using Dynamic maps Software. This was also solved and accomplished.

CHAPTER TWO

2.0 METHODS

2.1 **Research design**:- The study was accomplished using a descriptive survey with a high level of detail at the catchment's level. To study social conditions, and how they relate to land use practices, one needs a survey that has a descriptive framework.

This design was found suitable for the problem investigated and for collecting the necessary socio-economic information as outlined in the objectives of the study (definition of farm types).

The selection of the study sites was by the purposive sampling method. In this case a researcher has a bias to certain issues which she/he bases on, to determine the study sites (Kasoma and pomeroy, 1996). The catchments selected related to ICRAF study on hydrology and its subsequent impact on different Land uses(Lus), (Siriri, 2000). Based on the objective of the study (definition, of farm types) I developed a questionnaire which I used to solicit the necessary information from the respondents. My internal supervisor then approved the questionnaire before I went to the field.

The research instrument (questionnaire) was pre-tested in order to establish its suitability for obtaining the necessary information from the population sample. The pre-testing targeted the heads of households in the selected catchments who happened to be farmers.

After the pre-test, adjustments were made on the research instrument which led to the final version (to see appendix later in final draft).

2.2 **Population sampling**:

The households in selected catchments of Katagata and Muko were selected by random sampling along a topo sequence ie from the hilltops, along the hill slopes, to the valley bottoms. For the case of Katagata the selection took place in the parishes of Butoobore, Kakore and Hamurwa while for Muko I covered the parishes of Karyengere and IKamero.

In Katagata's case a total of 34 respondents were interviewed while for Muko, 32 respondent were interviewed making a total of 66 as the overall sample size for the study. In each catchment, a list of names of household heads obtained from LC I Chairmen of the villages were obtained,and written on slip papers. Slip papers were then chosen at random after each internal of reshuffling. Each adult member was randomly selected in each household and interviewed most of the time outside the house and on very few occasions inside the house. Some members that were not available at home at the time of the visit were interviews from their gardens.

2.3 Data collection:

The study used a questionnaire to obtain information on social economic aspects of house holds like demographic data, land tenure systems, the different land use systems, farm implements, farm management and farm types. The questionnaire was both closed and open-ended. Open-ended questions solicited multi-response answers. J administered the questionnaire in form of interviews scheduled in Lukiiga (the local language) and I filled in the responses.

An interview was considered most appropriate as most of respondents were presumed semi/or illiterate, which would in turn increase the accuracy of the data collected.

Field observations were also employed to supplement the questionnaire. Such observations included the different LUs along the topo sequence, gender roles on the farm, land management practices like bench terracing, contour ploughing, planting of legume cover crops on terraces etc.

2.4 Data Analysis:-

The data collected was managed and processed using a series of tasks like cleaning, coding, entry and transformation in order to prepare the data in a form suitable for analysis.

The coded questions were entered in Microsoft Excel Version 95, and the coded electronic sheet was then converted to database files, which could be read by the statistical package for social scientists (SPSS) version 10.0. Analysis was performed using SPSS. Summary statistics like frequencies, percentages were used.

Descriptives like sample means of different variables were also used. Due to the parametric nature of the data collected, regression analyses, analysis of variances (ANOVA) were used to determine the significance of various variables. The definition of farm types was carried out using hierarchical cluster analysis (HCA) as presented in Chapter three.

2.5 Terms used in the study

Land use:This refers to activities carried out by man on land.

FarmingSystems(FS):A unique and reasonably stable arrangement of farming enterprises that the household manages according to well defined practices in response to physical,bilogical and socio-economical environment and in accordance to the household goals, preferences and resources.

Farm types(FTS):This refers to a group of farms having similar Farming systems(FS)

Hierarchical cluster Analysis(HCA): Is a statistical method for finding relatively homogeneous clusters of farms based on measured characteristics.

CHAPTER THREE

3.0 Results

Results were presented basing on the hierarchy of systems in agriculture with the farm system as the highest unit (Fresco, 1986). This section will include demographic characteristics of rural households, different land uses and farming systems. The farm system will be sub divided into cropping systems, soils, livestock system, farm management and finally derivation of farm types.

3.0 **Demographic characteristics of rural house holds**. An understanding of the socio-economic characteristics of the people in the selected catchments was necessary in order to explain the results obtained. These included gender, levels of education, number of dependants in the household, on farm and off-farm activities of the households, hours of work on the farm/the day, income from both on-farm and off-farm activities, land tenure systems and land fragmentation.

3.1 **Mean number of years spent in catchments by respondents**:

Out of 33 respondents in Muko, the mean no. of years spent in the village was 44.3 years which represented 50.8%. For Katagata out of 32 respondents, the mean number of years was 41.14 years which was 49.2%.

Table 1.1 Mean number of years spent in village and age of household head

	Mean	N	Std. Deviation	% of Total N
number of years spent in village				
Muko	44.3030	33	17.6396	50.8%
Katagata	41.1429	32	21.1235	49.2%
Total	42.8525	65	19.2162	100.0%
age of household head				
Muko	49.0588	33	15.6146	50.8%
Katagata	49.6552	32	15.1003	49.2%
Total	49.3333	65	15.2591	100.0%
hours of work per day				
Muko	6.7667	33	1.9772	50.8%
Katagata	6.8077	32	2.2275	49.2%

Total	6.7857	65	2.0777	100.0%
income from on farm activities				
Muko	422775.2	33	432768.56127	55.9%
Katagata	257257.2	26	270740.33578	44.1%
Total	349835.1	59	376557.69038	100.0%
income from off farm activities				
Muko	33757.6	33	95477.4287	55.9%
Katagata	38423.1	26	82266.9669	44.1%
Total	35813.6	59	89174.6590	100.0%
No. of dependants				
Muko	4.7059	34	2.8765	54.0%
Katagata	6.3448	29	3.2872	46.0%
Total	5.4603	63	3.1563	100.0%

3.1.2 **Age of house hold head.**

The mean age of respondents in Muko was 49.05 years which represented 50.8% while for Katagata the mean age of respondents was 49.65 years which represented 49.2% (see table 1.1)

3.1.3 **Hours of work per day.**

The mean hours of work/day on the farm in Muko was 6.7 hours which represented 50.8% while for Katagata it was 6.8 hours which represented 49.2% (see table 1.1)

3.1.4 **Income from on farm activities**: (see table 1.1)

The mean income of farmers in Muko was 422,775.2 shillings for 33 respondents which represented 55.9% while for Katagata the mean income was 257,257.2 shillings for 26 respondents which represented 44.1%.

3.1.5 **Number of dependants**. (see table 1.1)

The mean number of dependants for Muko was 4.7 people per house hold (N=34) which represents 54.0% while for Katagata it was 6.34 people per house hold which represented 46.0%.

3.1.6 **Gender of house hold head.**

In Muko there were 24 male respodents representing a percentage of 70.6% while female respondents were 10 people representing 29.4%. In Katagata there were 21 male respondents, which represented 72.4% while female respondents were 8, which represented 27.6%. This was attributed to the fact that males were more open and ready to be interviewed as compared to females. The latter were always shy and not willing to co-operate often times concealing information.

Table 1.2 Percent distribution of selected demographic characteristics

sex of household head	Catchment		Total
	Muko	Katagata	
male	24 70.6%	21 72.4%	45 71.4%
female	10 29.4%	8 27.6%	18 28.6%
Total	**34** **100.0%**	**29** **100.0%**	**63** **100.0%**
education of household head			
no formal education	15 44.1%	6 20.7%	21 33.3%
primary	14 41.2%	18 62.1%	32 50.8%
ordinary	3 8.8%	5 17.2%	8 12.7%
college	2 5.9%		2 3.2%
Total	34 100.0%	29 100.0%	63 100.0%

3.1.7 **Education of household head**:- (see Table 1.2)

In Muko 15 respondents amounting to 44.1% had no formal education, 14 respondents (41.2%) had ordinary level education, 2(5.9)% attained college education. This represented a total of 34 respondents. This shows that literacy level was low.

In Katagata, 6 respondents (20.7%) had no formal education, 18 respondents (62.1%), had primary education, 5 respondents (17.2%), had ordinary level education with none in college. This amounted to total of 29 respondents. The literacy level in Katagata was much higher than that in Muko.

3.1.8 Land tenure and size of plot holdings.

MUKO; N = 32, the mean size of land holding was 0.952 ha which represented 53.3%. Katagata; N=28, the mean size of land holding was 1.342 ha which represented 46.7%. This means that in each catchment area, the plot sizes were very small but much smaller in Muko as compared to Katagata.(Table 1.3)

Table 1.3Land tenure characteristics by catchment.

size of land holding	Mean	N	Std. Deviation	% of Total N
Muko	.9527	32	.8186	53.3%
Katagata	1.3422	28	.9770	46.7%
Total	1.1345	60	.9096	100.0%
no. of plots owned				
Muko	6.1727	33	2.9053	55.0%
Katagata	7.1111	27	3.0298	45.0%
Total	6.5950	60	2.9740	100.0%

Table 1.31

Size of land owned elsewhere

Catchment	Mean	N	Std. Deviation	% of Total N
Muko	.3915	20	.4643	45.5%
Katagata	.4758	24	.3943	54.5%
Total	.4375	44	.4193	100.0%

The number of plots in Muko; N=33 was 6.17 plots per house hold (55%) while for Katagata it was 7.1 plots per household (45.0%).

In Muko the mean number of plots owned elsewhere (in other villages) was 0.3915 (45.5%) while for Katagata, it was 0.4758 (54.5%). This implies that land fragmentation in Katagata was higher than in Muko. (see Table 1.31)

In Muko; N=30 (100%) respondents owned land, while in Katagata, N=24 (100%) owned land. In Muko, 11 respondents (50%) inherited land, 10 respondents (45.5) purchased land, (1 respondent; 4.5%) had other forms of land ownership ie

borrowing land for cultivation for a season. In Katagata 3 respondents (33.3%) inherited land, 6 respondents (66.7%) purchased land. In both catchments a lot of land is inherited (passed on from father to son) which accounted to splitting of law into smaller pieces hence accounting to increased law fragmentation. (see Table 1.3).

3.2.0 Land uses and farming systems;-

Farming systems in the selected catchment areas are closely related to the traditional three way pattern of Land use (LUP). The first element of this LUP is the cultivation of valley bottoms. The second element is the cultivation of the slopes and the ridges referred to as the 'highland'.

The highland is further subdivided into the highlands proper and the 'homestead' which forms the third element of the three fold system of LU. The homestead contains a small area, under 'mixed crops' characteristically referred to as 'home garden' crops. Other LUs like fallows will also be covered.

3.2.1 Topographic distribution per catchment

Katagata (see Table 1.1)

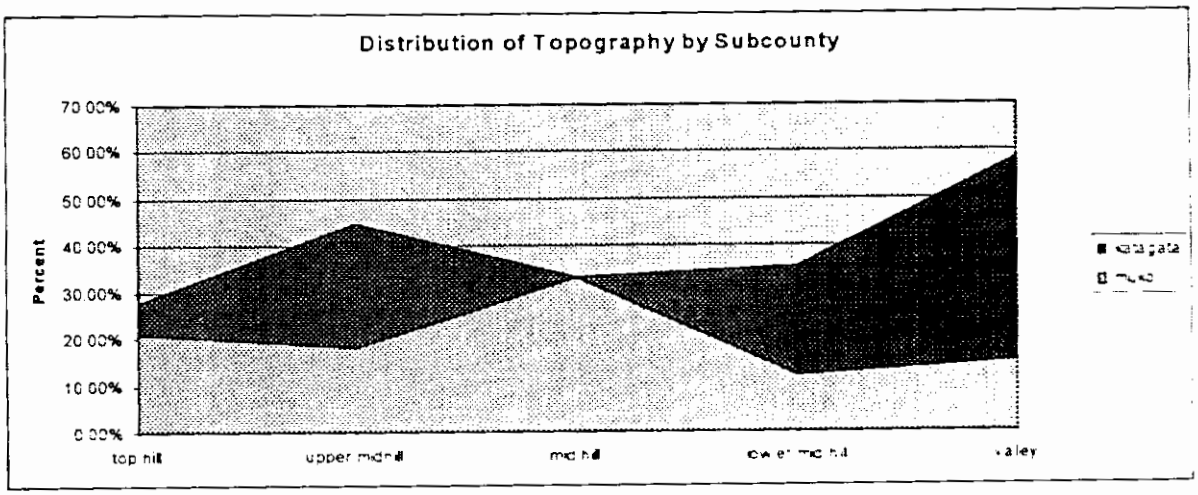
27% of farmers have land on top of hill, 45.5% farmers have land on upper slopes, 30% have land on middle slopes, 30%, lower slopes, 49% in the valley.

Muko

21% of farmers have land on top of hill, 18% upper slopes, 30% middle slopes, 10% lower slopes, 10% in the valley (see Figure 1.1)

This shows that for Katagata most land cultivation takes place on hill slopes and valley with little cultivation on hill tops. Muko, most cultivation is on hill slopes and hill tops with little cultivated in valleys.

Figure 1.1 Percent distribution of farmers who cultivate at different Topographic level in selected



3.2.2 Farming systems:-

4.0 land use with respect to toposequence

	Catchment	
Toposequence	muko	katagata
Hill top	peas	beans
	Sweet potatoes	i. potatoes
	sorghum	sorghum
	beans	peas
	i. potatoes	sw. pot
		food crops
		eucalyptus
		millet
		apples
		wheat
		grazing
Upper midslope	peas	sw. pot
	beans	food crops
	i. potatoes	beans

	maize eucalyptus settlement sorghum sw. pot	peas eucalyptus grazing	
midslope	beans sw. pot sorghum peas i. potatoes maize eucalyptus	i. potatoes sorghum beans sw. pot peas millet	
Lower midslope		peas beans i. potatoes eucalyptus millet	

Table 1.31Land under fallow with respect to toposequence

Catchment	topographic position	whether keeps land under fallow		Total
		No	Yes	
muko	top hill	7 23.3%		7 21.2%
	upper midhill	5 16.7%	1 33.3%	6 18.2%
	mid hill	9 30.0%	2 66.7%	11 33.3%

	lower mid hill	4 13.3%		4 12.1%
	valley	5 16.7%		5 15.2%
		30 100.0%	3 100.0%	33 100.0%
Katagata	top hill	2 9.1%		2 6.9%
	upper midhill	7 31.8%		7 24.1%
	lower mid hill	4 18.2%	3 42.9%	7 24.1%
	valley	9 40.9%	4 57.1%	13 44.8%
		22 100.0%	7 100.0%	29 100.0%

Muko: On the hill tops of Muko the farmers grow peas, sweet potatoes, sorghum, beans, 1. Pot upper slopes: farmers grow peas, beans, 1. Pot maize, eucalyptus, settlement, sorghum Sw.pot middle slopes: farmers grow beans, Sweet potatoes, sorghum, peas, 1 pot, maize, eucalyptus Lower slopes. Sorghum, beans, sweet potatoes. Valley: 1 potatoes, sweet potatoes, beans, sorghum, peas, maize, eucalyptus.

Katagata

Valley - farmers grow Irishpotatoes , sorghum, beans, sweetpotatoes, peas, climbing beans (exotic).

Lower slopes: farmers grow millet, eucalyptus grazing.

Hilltop: beans, 1 pot, sorghum, peas, sweetpotatoes, peas, eucalyptus, millet, wheat, grazing.(Table 4.0)

3.2.3 Fallows:- MUKO - 7 farmers (23.3%) do not fallow land on top of hill, 5 farmers (16.7%) upper slopes, a farmers (30%) middle slopes 4 farmers (13.3%) fallow lower slopes, 5 farmers (16.7%) fallow valley bottoms

Upper slopes

Katagata 2 farmers (9.1%) do not fallow on top of hill, 7 farmers (31.8%) do not fallow on upper slopes, 4 farmers (18.2%) lower slopes, a farmers (40.9%) valley bottoms.(table 1.31)

Table 6.0 .. mean acreages of farms by fallow status

whether keeps land under fallow	Mean	N	Std. Deviation	% of Total N
no	1.0964	51	.9151	85.0%
yes	1.3502	9	.8978	15.0%
Total	1.1345	60	.9096	100.0%

3.2.4 Home gardens

Table 4.6... Mean of yields of selected crops grown around the homestead and far away

	Muko	Katagata
Crops grown away from homesteads		
beans	152.6667	105.8333
i. potatoes	2560.0000	913.3333
sorghum	557.5000	511.0000
Crops grown around homesteads		
beans	170.2000	120.2500
i. potatoes	204.4444	225.0000
peas	30.0000	30.0000
bananas	10.3333	5.0000

Common crops grown in both catchments are beans (local), climbing beans (exotic), 1. Potatoes, peas, bananas. Crops grown far away from homesteads.

Table 4.7Land use with respect to distance from homestead

	Catchment area	
	Muko	Katagata
Crops grown away from homesteads	beans i. potatoes sorghum sw. pot	beans i. potatoes sorghum sw. pot

	peas	peas
	maize	maize
	bananas	millet
	millet	cabbages
	onions	wheat
	wheat	bananas
	passion fruit	onions
		tobacco

Cropping calender: Both catchments have got two seasons. The first season of prolonged rains stretches from Sept-October to February while second season with short rains stretches from March - August. Sorghum is planted around December - January and harvesting is in July - August. Beans from March - April planting season while harvesting is July - August. Peas - March planting - harvesting in July sweet potatoes, continuously planted as its major staple food except when very dry, millet planted in September and harvested in February - March.

Wheat is planted in March - April and harvested in August.

Table 4.8 .. cropping calendar by catchment area

Muko					
Year1		**Year2**		**Year3**	
Season 1 Sept-Feb.	*Season 2 Mar-aug*	*Season 1 Sept-Feb.*	*Season 2 Mar-aug*	*Season 1 Sept-feb*	*Season 2 Mar-aug*
sorghum	peas	sorghum	beans	sorghum	beans
sw. pot	beans	i. potatoes	peas	sw. pot	i. potatoes
beans	i. potatoes	beans	i. potatoes	beans	peas
i. potatoes	sorghum	sw. pot	sorghum	i. potatoes	sw. pot
maize	maize	peas	maize	peas	maize
peas	sw. pot	maize	sw. pot	maize	sorghum

Katagata		
Year1	**Year2**	**Year3**

Season 1 Sept-Feb.	*Season 2 Mar-aug*	*Season 1 Sept-Feb.*	*Season 2 Mar-aug*	*Season 1 Sept-feb*	*Season 2 Mar-aug*
sorghum	beans	sorghum	beans	sorghum	beans
sw. pot	i. potatoes	beans	i. potatoes	sw. pot	peas
i. potatoes	peas	i. potatoes	peas	beans	i. potatoes
beans	maize	peas	sorghum	i. potatoes	sorghum
peas	sorghum	sw. pot	sw. pot	peas	sw. pot
maize		cabbages	maize	cabbages	maize
cabbages			wheat		

Crop rotation sequence in Muko is sorghum → peas → sorghum → beans

Katagata: sorghum/sweet potatoes → beans/1.pot → sorghum/beans → beans/1. Potatoes - peas.

Table4.8 .. cropping calendar by catchment area

Muko					
Year1		**Year2**		**Year3**	
Season 1 Sept-Feb.	*Season 2 Mar-aug*	*Season 1 Sept-Feb.*	*Season 2 Mar-aug*	*Season 1 Sept-feb*	*Season 2 Mar-aug*
sorghum	peas	sorghum	beans	sorghum	beans
sw. pot	beans	i. potatoes	peas	sw. pot	i. potatoes
beans	i. potatoes	beans	i. potatoes	beans	peas
i. potatoes	sorghum	sw. pot	sorghum	i. potatoes	sw. pot
maize	maize	peas	maize	peas	maize
peas	sw. pot	maize	sw. pot	maize	sorghum
Katagata					
Year1		**Year2**		**Year3**	
Season 1 Sept-Feb.	*Season 2 Mar-aug*	*Season 1 Sept-Feb.*	*Season 2 Mar-aug*	*Season 1 Sept-feb*	*Season 2 Mar-aug*
sorghum	beans	sorghum	beans	sorghum	beans
sw. pot	i. potatoes	beans	i. potatoes	sw. pot	peas
i. potatoes	peas	i. potatoes	peas	beans	i. potatoes
beans	maize	peas	sorghum	i. potatoes	sorghum
peas	sorghum	sw. pot	sw. pot	peas	sw. pot

maize cabbages		cabbages	maize wheat	cabbages	maize

3.2.5 Perennial crops:

Table 4.9...percent distribution of perennial crops grown by catchment area

		1	2	
eucalyptus	7	20	14	34
		52.6	38.9	45.9
avocado	12	1	5	6
		2.6	13.9	8.1
bananas	15	11	9	20
		28.9	25	27
avocado	22	2	0	2
		5.3	0	2.7
cyprus	28	1	0	1
		2.6	0	1.4
eucalyptus	31	2	5	7
		5.3	13.9	9.5
guavas	35	0	2	2
		0	5.6	2.7
coffee	36	1	1	2
		2.6	2.8	2.7
Column		38	36	74
Total		51.4	48.6	100

3.2/6 Factors that determine crop yield in Muko and Katagata (see Table 4.9)

Factors such as fallows, soil fertility, level of education were tested using linear regression analysis. From the table, soil fertility had a high level of impact on yields with a standardized coefficient of 4-605 followed by dist of plots from homestead (444).

Null hypothesis: There is no significance in crop yield between two catchment areas. Using soil fertility of t =-8.158) compared to R(2) = 45.7%, 0.457. There is significant difference in yield in two catchments. (see table 4.9)

Table 4.9 .. Factors that determine crop yield in both catchments (n=28)

Factors	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	2.287	.506		4.521	.000		
fallow	.622	.077	.398	8.078	.000	.879	1.138
Soil3	-.684	.087	-.565	-7.835	.000	.410	2.442
SOIL1	-.819	.100	-.605	-8.158	.000	.388	2.579
CATRCHME	.476	.066	.393	7.191	.000	.712	1.405
LNDIST	.131	.019	.444	6.891	.000	.514	1.945
LNAGE	.801	.142	.371	5.621	.000	.489	2.045
SOIL2	-.293	.113	-.167	-2.592	.010	.515	1.941
EDUC	-.164	.068	-.114	-2.403	.017	.952	1.050

a Dependent Variable: LNYILD (R squared =45.7 %)

A comparison was made between farmer who fallow their law and those who don't fallow using ANOVA.

Ho: There is no significant difference in the means of the farmers who fallow law and those who do not.

P = 0.445 > 0.05 which implies there is a difference in means.

Table6.1 ..... Differences between fallow and non fallow farmers

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.493	1	.493	.591	.445
Within Groups	48.319	58	.833		
Total	48.811	59			

3.2.7 Fruit growing (Horticulture)

Table 6.2... Percent distribution of fruit trees

Category label	Code	Count	Pct of Responses	Pct of Cases
beans	1	47	18.7	74.6
i. potatoes	2	53	21	84.1

peas	4	13	5.2	20.6
sw. pot	5	3	1.2	4.8
maize	6	21	8.3	33.3
cabbages	8	4	1.6	6.3
apples	9	13	5.2	20.6
pears	10	2	0.8	3.2
plums	11	2	0.8	3.2
avocado	12	11	4.4	17.5
tree tomato	13	16	6.3	25.4
bananas	15	21	8.3	33.3
pumpkins	16	2	0.8	3.2
onions	19	2	0.8	3.2
wheat	20	1	0.4	1.6
avocado	22	2	0.8	3.2
paw paw	23	10	4	15.9
tobacco	27	4	1.6	6.3
passion fruit	30	4	1.6	6.3
guavas	35	8	3.2	12.7
coffee	36	6	2.4	9.5
passion fruit	37	1	0.4	1.6
g. nuts	38	2	0.8	3.2
	48	2	0.8	3.2
	60	2	0.8	3.2
		---	---	---
	Total respons	es 252	100	400

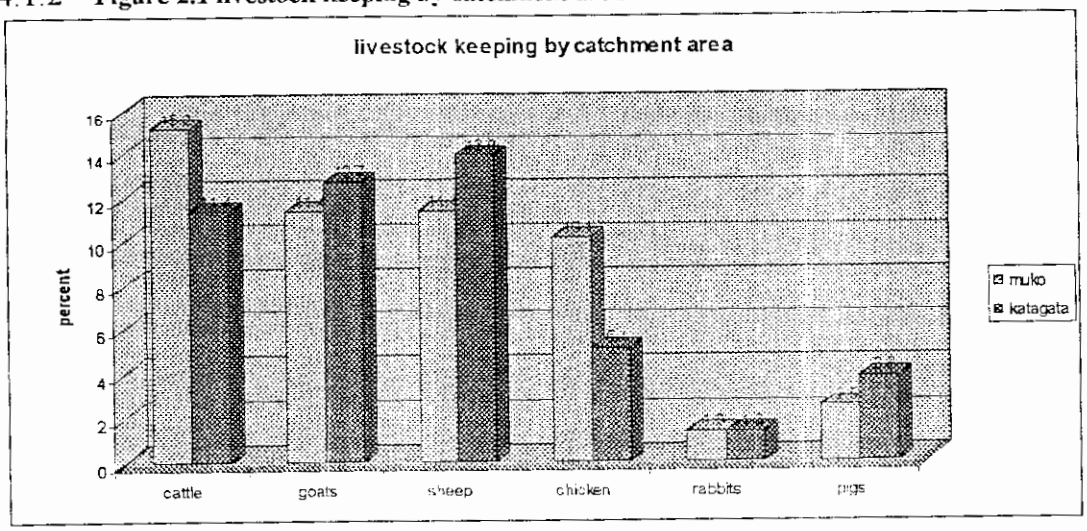
4.0 Livestock activities.

4.1 7.0Livestock keeping by catchment:

Livestock	Subcounty		
	muko	Katagata	
cattle	12 29.3	9 23.7	21 26.6
Goats	9 22	10 26.3	19 24.1

Sheep	9 22	11 28.9	20 25.3
Chicken	8 19.5	4 10.5	12 15.2
Rabbits	1 2.4	1 2.6	2 2.5
Pigs	2 4.9	3 7.9	5 6.3
Column Total	41 51.9	38 48.1	79 100

4.1.2 **Figure 2.1 livestock keeping by catchment area**



4.1.3 **table7.1 total number of livestock by catchment area**

	Cattle	Goats	Sheep	Chicken	Rabbits	Pigs	
Muko	34 28.6	25 21	30 25.2	22 18.5	1 0.8	7 5.9	119 100
Katagata	30 27.3	25 22.7	34 30.9	13 11.8	1 0.9	7 6.4	110 100

4.1.4 **Table7.2 .. rate of commercialization of livestock produce**

		Milk in litres	Meat in KGS	Eggs No.	

Muko	Home consumption	8	14	10	32
		25	43.8	31.3	100
	For sale	9	14	3	26
		34.6	53.8	11.5	100
Katagata	Home consumption	15	29	6	50
		30	58	12	100
	For sale	16	30	6	52
		30.8	57.7	11.5	100

4.1.5 **Table7.3 ...on farm activities with respect to cropping and livestock keeping**

	Catchment area	
	Muko	**Katagata**
Cropping activities	thinning	thinning
	harvesting	harvesting
	weeding	manuring
	planting seeds	planting seeds
	ploughing	weeding
	spraying	ploughing
	manuring	spraying
		pruning
		pplant. impr. fallows
		fencing
		grazing
Livestock related activities		

5.0 Farm management

5.1 Soil management

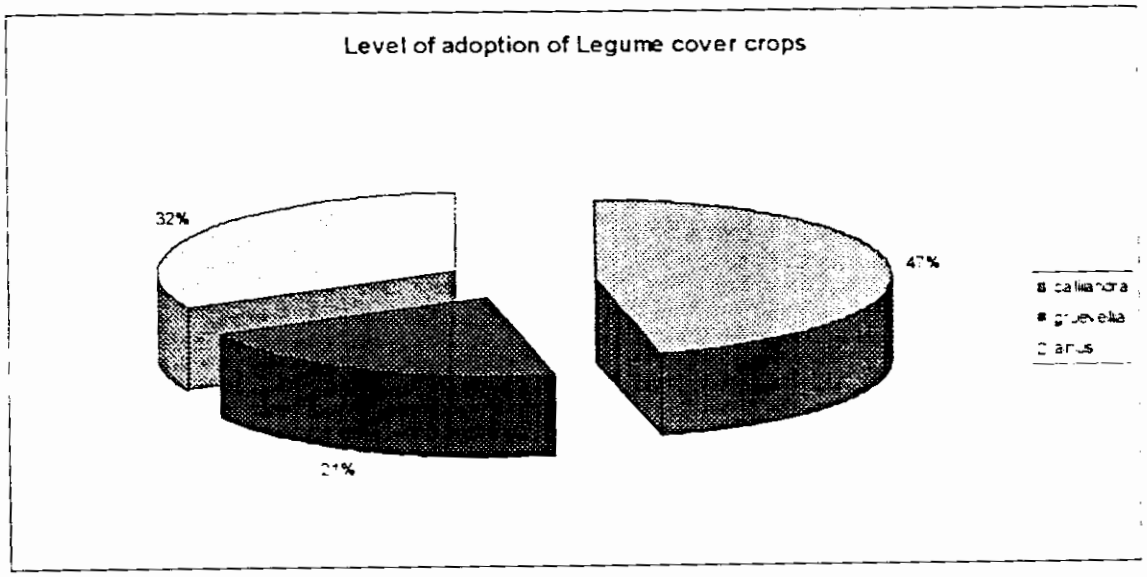
Table 7.4... steps taken to maintain terraces

Steps	Code	Count	Pct of Responses	Pct of Cases
	1	15	18.3	23.8
	2	17	20.7	27
	3	27	32.9	42.9
	4	3	3.7	4.8
	5	5	6.1	7.9
	6	8	9.8	12.7
	7	2	2.4	3.2
	8	3	3.7	4.8
	9	2	2.4	3.2
	Total responses	82	100	130.2

5.1.2 **Table7.5 ... reasons for planting trees on the terraces**

Category label	Code	Count	Pct of Responses	Pct of Cases
	1	46	76.7	95.8
	2	3	5	6.3
	3	2	3.3	4.2
	4	7	11.7	14.6
	6	2	3.3	4.2
	Total responses	60	100	125

Level of adoption of land cover crops



5.1.3 **Table7.6 .. reasons terraces are still intact**

Category label	Code	Count	Pct of Responses	Pct of Cases
	1	14	23	25
	2	12	19.7	21.4
	3	3	4.9	5.4
	4	10	16.4	17.9
	5	6	9.8	10.7
	6	4	6.6	7.1
	7	2	3.3	3.6
	8	2	3.3	3.6
	9	8	13.1	14.3
	Total responses	61	100	108.9

5.1.4 **table7.7.. main uses of cover crops in muko**

	calliandra	gruevellia	alnus	Row Total
prevent soil erosion	9	2	6	17
	60	25	50	48.6
for timber	2	2	2	6
	13.3	25	16.7	17.1
firewood	2	4	2	8
	13.3	50	16.7	22.9
4	2	0	2	4

fix nitrogen	13.3	0	16.7	11.4
Column	15	8	12	35
Total	42.9	22.9	34.3	100

5.1.5 **Table7.8.. main uses of cover crops in Katagata**

Count Col pct	calliiandra	gruevellia	alnus	Row Total
prevent soil erosion	18	1	17	36
	30	4.3	34.7	27.3
for timber	4	4	0	8
	6.7	17.4	0	6.1
firewood	3	3	3	9
	5	13	6.1	6.8
maintain soil fertility	19	6	16	41
	31.7	26.1	32.7	31.1
show demarcation	2	0	2	4
	3.3	0	4.1	3
fodder for animals	5	3	5	13
	8.3	13	10.2	9.8
stakes for climbing beans	6	6	3	15
	10	26.1	6.1	11.4
wind breakers	1	0	1	2
	1.7	0	2	1.5
drain soils	2	0	2	4
	3.3	0	4.1	3
Column	60	23	49	132
Total	45.5	17.4	37.1	100

5.1.6 **Table 7.9.. Mean area under cover crops in both catchments**

Report

area under cover crops

SUB	Mean	N	Std. Deviation	% of Total N
Muko	1.163E-02	43	3.244E-02	68.3%
Katagata	.1033	20	9.814E-02	31.7%
Total	4.071E-02	63	7.425E-02	100.0%

5.1.7 **Table8.0 .. areas where cover crops are grown in Muko**

Count Row pct Col pct	calliiandra	gruevellia	alnus	Row Total
Boundaries of plots	9 47.4 69.2	4 21.1 66.7	6 31.6 60	19 65.5
Pure stands in plots	4 40 30.8	2 20 33.3	4 40 40	10 34.5
Column Total	13 44.8	6 20.7	10 34.5	29 100

5.1.8 **Table8.1 .. areas where cover crops are grown in Katagata**

Count Row pct Col pct	calliiandra	gruevellia	alnus	Row Total
Boundaries of plots	19 46.3 46.3	8 19.5 42.1	14 34.1 45.2	41 45.1
Pure stands in plots	22 44 53.7	11 22 57.9	17 34 54.8	50 54.9
Column Total	41 45.1	19 20.9	31 34.1	91 100

6.0 **Derivation of Farm types:**

Hierarchical cluster analysis was used to group the various land use systems into farm types. Following are the characteristics of the four distinct farm types that were identified. About 9 farm types stood out individually and could not be classified into the four main groups and were hence excluded from the analysis.

6.1 **Table 1.50 Classification of farm systems into farm types using Hierarchical Cluster analysis by catchment**

Farm type	Catchment area		Total
	muko	katagata	

farm type 1	19 65.5%	11 40.7%	30 53.6%
farm type 2	6 20.7%	5 18.5%	11 19.6%
farm type 3	1 3.4%	6 22.2%	7 12.5%
farm type 4	3 10.3%	5 18.5%	8 14.3%
Total column	29 100.0%	27 100.0%	56

6.1.2 **Table 1.5 Classification of farm systems into farm types using Hierarchical Cluster analysis**

size of land holding	Mean	N	Std. Deviation	% of Total N
farm type 1	.9629	30	.4755	53.6%
farm type 2	.9171	11	.7876	19.6%
farm type 3	1.2553	7	.7646	12.5%
farm type 4	.9728	8	.7377	14.3%
Total	.9919	56	.6128	100.0%
Number of dependants				
farm type 1	4.5667	30	2.2997	53.6%
farm type 2	5.4545	11	2.9787	19.6%
farm type 3	7.8571	7	2.4103	12.5%
farm type 4	5.1250	8	2.5319	14.3%
Total	5.2321	56	2.6423	100.0%

whether keeps land under fallow * Average Linkage (Between Groups) Crosstabulation

whether keeps land under fallow	farm type				Total
	farm type 1	farm type 2	farm type 3	farm type 4	
No	30 100.0%	11 100.0%		8 100.0%	49 87.5%
yes			7 100.0%		7 12.5%
	30 100.0%	11 100.0%	7 100.0%	8 100.0%	56 100.0%

whether has woodlots on plots					Total
no		11 100.0%			11 19.6%
yes	30 100.0%		7 100.0%	8 100.0%	45 80.4%
	30 100.0%	11 100.0%	7 100.0%	8 100.0%	56 100.0%
whether has shortage of labour	1	2	3	4	
No	10 33.3%	11 100.0%		5 62.5%	26 46.4%
yes	20 66.7%		7 100.0%	3 37.5%	30 53.6%
	30 100.0%	11 100.0%	7 100.0%	8 100.0%	56 100.0%
whether uses any agro_chemicals					
No	15 50.0%	8 72.7%	3 42.9%	3 37.5%	29 51.8%
yes	15 50.0%	3 27.3%	4 57.1%	5 62.5%	27 48.2%
	30 100.0%	11 100.0%	7 100.0%	8 100.0%	56 100.0%
fertilizer used					
No	30 100.0%	10 90.9%	3 42.9%		43 76.8%
yes		1 9.1%	4 57.1%	8 100.0%	13 23.2%
	30 100.0%	11 100.0%	7 100.0%	8 100.0%	56 100.0%

Soil type	1	2	3	4	
orucucu	29 37.7	10 38.5	4 23.5	7 33.3	50 35.5

enombe2	22 28.6	8 30.8	3 17.6	8 38.1	41 29.1
eibumba3	13 16.9	5 19.2	7 41.2	0 0	25 17.7
stony4	3 3.9	0 0	0 0	2 9.5	5 3.5
orushenyi5	1 1.3	0 0	2 11.8	1 4.8	4 2.8
Volcanic solis7	0 0	0 0	0 0	2 9.5	2 1.4
ekigogwe8	2 2.6	3 11.5	0 0	0 0	5 3.5
namabare10	2 2.6	0 0	0 0	0 0	2 1.4
orubumba12	2 2.6	0 0	1 5.9	1 4.8	4 2.8
ibaabe13	3 3.9	0 0	0 0	0 0	3 2.1
Column Total	77 54.6	26 18.4	17 12.1	21 14.9	141 100

Soil classification was based on indegenous(local language).

topographic position * Average Linkage (Between Groups) Crosstabulation

topographic positio					
	1	2	3	4	
top hill	4 13.3%	2 18.2%		1 12.5%	7 12.5%
upper midhill	4 13.3%	4 36.4%		3 37.5%	11 19.6%
mid hill	7 23.3%	1 9.1%	1 14.3%	1 12.5%	10 17.9%
lower mid hill	7 23.3%		2 28.6%	1 12.5%	10 17.9%
valley	8 26.7%	4 36.4%	4 57.1%	2 25.0%	18 32.1%
	30 100.0%	11 100.0%	7 100.0%	8 100.0%	56 100.0%

6.1.3 Land use

Table 3.0 Percent distribution of various inputs used by Sub-County

Type of farm implement	Sub-County		
	muko	katagata	
hoes	32	29	61

	37.2	38.7	37.9
pangas	33	30	63
	38.4	40	39.1
sprayer	6	6	12
	7	8	7.5
sickles	8	5	13
	9.3	6.7	8.1
slasher	4	3	7
	4.7	4	4.3
pickaxe	2	1	3
	2.3	1.3	1.9
axe	1	1	2
	1.2	1.3	1.2
Column	86	75	161
Total	53.4	46.6	100
Source of labour			
hires	12	11	23
	30	29.7	29.9
Family labour	28	26	54
	70	70.3	70.1
Column	40	37	77
Total	51.9	48.1	100

Frequency of pesticide use	muko	katagata	
Once a week	19	20	39
	86.4	87	86.7
Thrice a week	1	1	2
	4.5	4.3	4.4
Twice a week	2	2	4
	9.1	8.7	8.9
Column	22	23	45
Total	48.9	51.1	100
Reasons for not using herbicides			
Lack of funds	7	7	14
	100	87.5	93.3

Ignorant of availability of pesticides	0 0	1 12.5	1 6.7
Column Total	7 46.7	8 53.3	15 100

	1	2	
Twice a month	4 50	2 20	6 33.3
Any time available	1 12.5	0 0	1 5.6
Once a week	1 12.5	1 10	2 11.1
Once a month	2 25	0 0	2 11.1
3 basins per week	0 0	1 10	1 5.6
5 basins a day	0 0	5 50	5 27.8
daily	0 0	1 10	1 5.6
Column Total	8 44.4	10 55.6	18 100

Frequency of fertilizer use			
daily to thrice a week	0 0	6 60	6 33.3
once a week to twice a week	2 25	2 20	4 22.2
once a fortnight to once a month	6 75	2 20	8 44.4
Column Total	8 44.4	10 55.6	18 100

Type Of Soil	1	2	
orucucu	21 39.6	12 31.6	33 36.3
	13	10	23

enombe	24.5	26.3	25.3
	8	6	14
eibumba	15.1	15.8	15.4
	3	2	5
stony	5.7	5.3	5.5
orushenyi	2	3	5
eibumbe	3.8	7.9	5.5
	1	0	1
volcanic soils	1.9	0	1.1
	1	0	1
murram	1.9	0	1.1
	2	0	2
ekigogwe	3.8	0	2.2
	1	1	2
erinkwiragure	1.9	2.6	2.2
	0	3	3
orubumba	0	7.9	3.3
	1	1	2
ibaade	1.9	2.6	2.2
Column	53	38	
Total	58.2	41.8	91

PROGRESS REPORT

TITLE OF RESEARCH: MAPPING LAND COVER AND LAND USE CHANGE IN KABALE

OBJECTIVES:

- To map recent land cover in the study area at district level.
- Derive land use from the land cover map.
- Identify hot spots using vegetation index.
- Interpret change in vegetation index in terms of land cover/use change.

ACTIVITIES COMPLETED:

- *Map recent land cover in the study area at district level.*
- *Derive land use from land cover map.*
- *Identify hot spots using vegetation index.*
- *Interpreting changes from vegetation index in terms of land cover and land use.*

Data acquired.

Landsat TM imagery 2000 and 1987 from the institute.

Spot HVR imagery 1993 from NBS.

Topographic sheets from department of lands and survey in Entebbe.

Ancillary data on crop calendar from the field.

Literature on farming systems from ICRAF and Tele-center in Kabale and magazines from MUIENR.

Groundtruth information on land cover/use from Kabale.

Digital data on land use and land cover

Image processing.

Landsat TM of 1987, 2000 and Spot 1993 imagery have been registered to Toposheets of the study area.

A land cover mapping has been completed.

Final land use map has been derived from land cover.

Hot spots using vegetation index have been identified.

Vegetation index in terms of land use land cover have been interpreted.

Activities remaining.

Making corrections after my supervisor has gone through the work. I will be sending my draft early may to him.

Difficulties faced.

Cloud cover within the image, which is problematic to classification.

The terrain of Kabale (high intensity) made it difficult to carry out fieldwork.

In Maziba subcounty, the collapse of the bridge made some places to be inaccessible.

The breakdown of the computer at MUTENR has been the biggest obstacle in my work because I lost three quarters of my work.

Having little time of doing the work in the lab because of the on going studies.

Yours sincerely

Nahya Nkinzi (Student MUTENR)

GISD Project
Annex 3

Subcontracts With
United States Geological Survey's (USGS) Earth Resources Observation Systems (EROS) Data Center (EDC)

IFDC Contracts
01599/02
01600/02
01617/02

1. Project Summary Pages
2. Project Memorandum of Understandings
3. Project Final Reports

	Project Summary Page
MOU Lead Implementation Organization	**United States Geological Survey's (USGS) Earth Resources Observation Systems (EROS) Data Center (EDC)**
Contact Person	Mr. Larry L. Tieszen Deputy Manager International Programs EROS Data Center, USGS Sioux Falls, SD 57198, USA Telephone: 605/594-5056 Fax: 605/594-6529 tieszen@edcmail.cr.usgs.gov http://edcintl.cr.usgs.gov/ip
Project/Program and Statement of Work	Target Region 1: Upper Niger Basin: **Case Studies in Upper Niger River Basin: Sustainable Livelihoods that Balance Natural Resource Conservation and Agricultural Production in the OHVN Zone and the Yatenga Plateau** USGS-EDC, in collaboration with OHVN, INSAH, AGRHYMET, CONAGESE and PNGIM will monitor, map and quantify trends in land cover, land use, and land productivity from the mid-1960's to the present, focusing on two study areas: the OHVN Zone of Mali in the Upper Niger River Basin, and the Yatenga Plateau of northern Burkina. A description of the activities to be undertaken by USGS-EDC, technical procedures to be followed, deliverables required, and estimated schedule are presented in Attachment 1 of the MOU. Attachment 1 is incorporated as an integral part of this Memorandum of Understanding (MOU).
Collaborating Institutions	OHVN, INSAH, CONAGESE, PNGIM
IFDC Contract Number	01599/02
Budget Amount	Signed contract with USGS for $148,488 on November 5, 2001
Amendment(s)	None
Extension Ending Date	

IFDC 01599 02

INTERNATIONAL FERTILIZER DEVELOPMENT CENTER • MUSCLE SHOALS ALABAMA 35662 USA
P.O BOX 2040 • 256-381-6600
EMAIL-general@IFDC.org
TELEFAX NO. 256-381-7408

Memorandum of Understanding

Between

International Fertilizer Development Center
PO Box 2040
Muscle Shoals, AL 35662, USA

And

United States Geological Survey's (USGS) Earth Resources Observation Systems (EROS) Data Center (EDC)
Sioux Falls, SD 57198, USA

October 1, 2001

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Sioux Falls, SD 57198, USA

The International Fertilizer Development Center (hereinafter referred to as IFDC) is a public international organization (PIO) dedicated to increasing sustainable agricultural production through the improved use of yield enhancing technologies. USGS-EDC has submitted a proposal to USAID to work with OHVN, INSAH, AGRHYMET, CONAGESE, and PNGIM to monitor, map, and quantify trends in land cover, land use, and land productivity in selected zones of Mali and Niger. In order to carryout the work described herein, IFDC and USGS-EDC hereby agree to the following terms and conditions:

1.0 INTRODUCTION AND STATEMENT OF WORK

The United States Agency for International Development (USAID) has entered into an Agreement with IFDC for IFDC to undertake a project entitled "Quick Start for Agriculture in Africa" to support the Geographic Information for Sustainable Development (GISD) project leading up to the World Summit on Sustainable Development (WSSD).

IFDC will provide USAID EGAD AFS with logistical and management support to the various partners involved in the implementation of the GISD project, including transferring and providing overall fiscal oversight to specific "pass-through" funds to selected partners who are

BEST AVAILABLE

being asked to implement specific GISD activities. This will include work already identified in specific proposals from the NRC, OGC, and several other groups located in the four Target Regions: Upper Niger Basin, African Great Lakes Region, the Kenya-Tanzania Coastal Zone, and the Limpopo/Zambeze River Basin Region of southern Africa.

IFDC will work in close collaboration with the technical officers within USAID providing oversight: Note: The Overall Coordinator is Robert E. Ford, AEMD – Agricultural Enterprise and Market Development Division within USAID's office of Agriculture and Food Security. Robert E. Ford is the Chair of the GISD-IWG for Regional Applications sub-group.

Close coordination must also occur with co-Chairs of the GISD-IWG for each sub-region. They are: Barbara Best (G/ENV) for the Kenya-Tanzania CZM Activity; Paul Bartel and Jon Anderson (AFR-SD) for the Four Corners/Limpopo/Zambezi Basin region; Robert Ford for the Great Lakes/Great Horn of Africa Region; and Mike McGahuey (USAID/AFR-SD).

USGS-EDC, in collaboration with OHVN, INSAH, AGRHYMET, CONAGESE and PNGIM will monitor, map and quantify trends in land cover, land use, and land productivity from the mid-1960's to the present, focusing on two study areas: the OHVN Zone of Mali in the Upper Niger River Basin, and the Yatenga Plateau of northern Burkina. A description of the activities to be undertaken by USGS-EDC, technical procedures to be followed, deliverables required, and estimated schedule are presented in Attachment 1, which is incorporated as an integral part of this Memorandum of Understanding (MOU).

2.0 SPECIFIC CONDITIONS

2.1 *Effective Dates of MOU*

The effective dates of this MOU are October 1, 2001-September 30, 2002.

2.2 Finance

The work to be performed under this MOU is being financed by USAID with all funds channeled to IFDC. IFDC shall provide funding to USGS-EDC in accordance with the terms and conditions described in this MOU. USGS-EDC shall develop subagreements as necessary to support funding arrangements and the work to be performed by its collaborating institutions. The estimated funds available to USGS-EDC total US $148,488 (one hundred forty-eight thousand, four hundred eighty-eight) as follows:

Item	Total US $
Staffing	90,093
Travel Costs	26,500
Data Services Products	20,118
Other Costs	11,777
GRAND TOTAL	**148,488**

2.2.1 Use of Funds

IFDC has fiduciary responsibility of funds received from USAID. Under the terms of this MOU, all funds provided to USGS-EDC shall be utilized solely for the purposes indicated in the budget under 2.2. Said funds shall cover all expenditures necessary for the services to be performed by and or arranged by USGS-EDC. IFDC shall not be responsible for any additional costs (i.e., above US $148,488) incurred in the performance of the work described under this MOU.

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2.2.2 Allowable Costs

(a) USGS-EDC shall be reimbursed for costs incurred in carrying out the purposes of this MOU, which are reasonable, allocable, and allowable.

(b) Reasonable shall mean those costs that do not exceed those which would be incurred by an ordinarily prudent person in the conduct of normal business.

(c) Allocable shall mean those costs that are necessary to the MOU.

(d) Allowable shall mean those costs which are reasonable and allocable, and which conform to any limitations set forth in this MOU.

(e) Prior to incurring a questionable or unique cost, USGS-EDC is encouraged to obtain IFDC's written determination as to whether the cost will be allowable.

2.2.3 Payments

IFDC shall make payments to USGS-EDC subject to the receipt of funds from USAID and based upon receipt of an official invoice from USGS-EDC. The invoice may be faxed to the official IFDC Business Contact indicated in 2.6.1. The payments shall be made quarterly on a cost reimbursable basis based upon USGS-EDC'S submission of financial reports, which substantiate costs incurred in the performance of this MOU.

2.2.4 Financial Reports

USGS-EDC shall provide to IFDC a financial report accounting for all allowable costs incurred by USGS-EDC under the program in accordance with the line item budget amounts indicated in 2.2. Copies of documentation to support all costs incurred in performance of work described in this MOU shall be made available to IFDC upon request.

2.2.5 Audit

USGS-EDC shall maintain books, records, documents, and other evidence in accordance with USGS-EDC's usual accounting procedures to sufficiently substantiate charges to this MOU. IFDC and USAID reserve the right to examine and USGS-EDC agrees to make available all financial records and documents of USGS-EDC as related to this MOU. Any costs that are determined by either IFDC or USAID to be inconsistent with the terms and conditions of this MOU shall immediately be refunded to IFDC. USGS-EDC is subject to the audit guidelines and provisions of 22 CFR Section 226.26. In accordance with the provisions of OMB Circular A-133, USGS-EDC is obligated to comply with the requirements of OMB Circular A-133. USGS-EDC is required to have an audit in full compliance with the guidelines of OMB A-133 and agrees that a copy of the audit report will be submitted to IFDC's supervisor, Accounting Services, by USGS-EDC within thirty (30) days of completion of the audit. By the signing of this MOU, USGS-EDC states that they were informed of, understand, and agree to comply with the applicable compliance requirements.

2.2.6 Refunds

(a) Funds not disbursed to USGS-EDC at the time the MOU expires or is terminated shall revert to IFDC, except for such funds encumbered by USGS-EDC by a legally binding transaction applicable to this MOU. Any funds advanced to but not expended by USGS-EDC at the time of expiration or termination of the MOU shall be refunded to IFDC except for such funds encumbered by USGS-EDC by a legally binding transaction applicable to this MOU.

(b) If, at any time during the life of the MOU, or as a result of final audit, it is determined that funds provided under this MOU have been expended for purposes not in accordance with the terms of this MOU, USGS-EDC shall refund such amount to IFDC.

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2.3 Language

The MOU has been executed in English, which shall be the binding and controlling language for interpretation of the terms and conditions of this MOU.

2.4 Sub-agreements

It is understood that USGS-EDC may carryout the work described under this MOU in collaboration with others. It is further understood that funds provided to USGS-EDC may be used to support work carried out by collaborating institutions. USGS-EDC shall ensure that the specific conditions of this MOU (i.e., Section 2.0, Specific Conditions) shall apply to all such sub-agreements.

2.5 Revision of MOU Budget

(a) The approved MOU budget is the financial expression of USGS-EDC's program.

(b) USGS-EDC shall immediately request approval from IFDC when there is reason to believe that within the next 30 calendar days a revision of the approved MOU budget will be necessary for any of the following reasons:

- To change the scope or the objectives of the program and/or revise the funding allocated among objectives by more than ten percent of the total budget amount unless the schedule states otherwise.
- Additional funding is needed.
- USGS-EDC expects the amount of authorized funds to exceed its needs by more than $5,000 or five percent of the MOU budget, whichever is greater.

(c) Except as required by other provisions of this MOU specifically stated to be an exception from this provision, IFDC shall not be obligated to reimburse USGS-EDC for costs incurred in excess of the total amount obligated under the MOU. USGS-EDC shall not be obligated to continue performance under the MOU (including actions under the "Termination Procedures" provision) or

otherwise to incur costs in excess of the amount obligated under the MOU, unless and until IFDC has notified USGS-EDC in writing that such obligated amount has been increased and has specified the new MOU total amount.

2.6 Other Terms and Conditions

The following terms and conditions, which are applicable to the MOU by and between USAID and IFDC, shall be integral part of this Agreement.

2.6.1 Official Contacts

The contacts under this MOU for all official contacts are as follows:

IFDC Technical
Dr. Lawrence L. Hammond
Director, Research and Development Division
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Muscle Shoals, AL 35662, USA
Telephone: 256/381-6600, extension 270
FAX: 256/381-7408
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IFDC Business
Mr. John H. Allgood
Director, Finance, Administration, and Support Services
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http://edcintl.cr.usgs.gov/ip

2.6.2 Publications and Media Releases

If it is USGS-EDC's intention to identify USAID's contribution to any publication, video or other information/media product resulting from this MOU, USGS-EDC shall state that the views expressed by the author(s) do not necessarily reflect those of USAID. Acknowledgments should identify the sponsoring USAID Office and Bureau or Mission as well as USAID substantially as follows:

"This [publication, video or other information/media project (specific)] was made possible through support provided by the Center for Economic Growth and Agricultural Development, Office of Agriculture and Food Security, under the terms of the MOU. The opinions expressed herein are those of the author(s) and do not necessarily reflect the views of USAID."

USGS-EDC shall provide the relevant strategic objective or results package team with one copy of all published works developed under this MOU and with lists of other written work produced under the MOU.

Except as otherwise provided in the terms and conditions of the MOU, the author or USGS-EDC is free to copyright any books, publications, or other copyrightable materials developed in the course of or under this MOU, but USAID reserves a royalty-free nonexclusive and irrevocable right to reproduce, publish,

or otherwise use, and to authorize others to use the work for U.S. Government purposes.

2.6.3 Reports and Data

USGS-EDC shall send to the IFDC Technical Contact at the address included in this MOU, monthly and quarterly progress reports in a form and substance satisfactory to IFDC. The monthly reports will provide a brief report on the status of activities being undertaken to implement this project during the previous 30 days.

The quarterly reports shall indicate progress toward achieving Program objectives and implementing approved work plans. The reports shall include, but not be limited to, the following information:

- Status of achievement of program goals, objectives, and benchmarks specified in the annual work plan
- Progress or completion of components, elements, or activities against planned targets
- Program description
- Other accomplishments or program highlights
- Identification and explanation of significant problems which have been encountered
- Description of planned corrective action

The monthly and quarterly reports may be submitted in electronic format and are to be delivered to IFDC within 7 calendar days and 20 calendar days, respectively, of the end of the reporting period. A final report addressing the same components included in the quarterly report is to be submitted to IFDC by USGS-EDC within 45 calendar days of the ending date of this MOU. The reports submitted to USGS-EDC to IFDC and supporting materials compiled in performing the services shall be the property of USAID.

BEST AVAILABLE

USGS-EDC is also required to submit copies of reports/publications, produced within each activity as requested by the USAID Cognizant Technical Officer (e.g., workshop proceedings, PowerPoint presentations, etc.).

2.6.4 Termination

This agreement may be terminated, in whole or in part, by either party at any time upon 30 days written notice of termination. Upon receipt of and in accordance with a termination notice from the IFDC, the USGS-EDC shall take immediate action to cease all expenditures financed by this MOU and to cancel all unliquidated obligations if possible. Further, upon receipt of notice of termination, the USGS-EDC shall not enter into any further obligations under this MOU. Except as provided below, no further reimbursement shall be made after the effective date of termination. The USGS-EDC shall within 30 days of the effective date of termination repay to IFDC all unexpended funds that are not otherwise obligated by a legally binding transaction applicable to this MOU. Should the funds paid by IFDC to the USGS-EDC prior to the effective date of termination be insufficient to cover the USGS-EDC's obligations in a legally binding transaction, the USGS-EDC may submit to IFDC within 90 days after the effective date of termination a written claim for such amount. The IFDC shall determine the amount(s) to be paid by IFDC to the USGS-EDC under such claim in accordance with the "Allowable Costs" provision of this MOU.

2.6.5 Dispute Settlement

Because of the nature of this agreement and legal status of the respective organizations engaged under this MOU, reconciliation of disputes which cannot be handled amicably will be settled through discussions/negotiations by and between the signatories to the MOU.

2.6.6 Investment Promotions

No funds or other support provided hereunder may be used in a program or activity reasonably likely to involve the relocation or expansion outside of the United States of an enterprise located in the United States if non-US production in such relocation or expansion replaces some or all of the production of, and reduces the number of employees at, said enterprise in the United States.

No funds or other support provided hereunder may be used in a program or activity the purpose of which is the establishment or development in a foreign country of any export processing zone or designated area where the labor, environmental, tax, tariff, and safety laws of the country would not apply, without the prior written approval of IFDC.

No funds or other support provided hereunder may be used in an activity which contributes to the violation of internationally recognized rights of workers in the recipient country including those in any designated zone or area in that country. This provision must be included in all sub-agreements.

2.6.7 Non-Liability

IFDC does not assume liability for any third party claims for damages arising out of this MOU.

2.6.8 Notices

Any notice given by either party under this MOU shall be sufficient only if in writing and delivered in person or faxed to the official contact persons identified in 2.5.1

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2.6.9 Special Provisions

USGS-EDC shall comply with USAID environmental regulations (22 CFR Section 216 "Regulation 16") with respect to the activities to be undertaken under this MOU.

2.6.10 Procurement Policies and Procedures

Because USAID is the sole contributor, USAID procurement policies and procedures are applicable (22 CFR Section 226 and ADS 308.5.7a).

2.6.11 Ineligible Countries

Activities under this agreement may only be carried out in countries that are eligible to receive assistance under the Foreign Assistance Act. USGS-EDC shall provide IFDC in advance a list of those countries where activities are planned under this MOU.

2.6.12 Entire MOU

Unless otherwise specified, this MOU embodies the entire understanding between IFDC and USGS-EDC for the services to be provided and any prior to contemporaneous representations, either oral or written, are hereby superseded. No amendments or changes to this MOU, including, without limitation, changes in the statement of work, total estimated cost, and period of performance, shall be effective unless made in writing and signed by authorized representatives of the parties.

FOR AND ON BEHALF OF IFDC

By: _____

Name: JOHN H ALLGOOD

Title: DIRECTOR, FINANCE & ADMIN

Date: Nov 5, 2001

WITNESS:

By: _____

Name: LAWRENCE HAMMOND

Title: Director R+D

Date: 5 NOV 2001

FOR AND ON BEHALF OF USGS-EDC

By: _____

Name: BARBARA J. RYAN

Title: Associate Director, Geography

Date: Dec 5, 2001

WITNESS:

By: _____

Name: Robert L. Lidwin

Title: Chief of Staff

Date: 12-05-01

Attachment I

DRAFT PROPOSAL DRAFT PROPOSAL

USGS-EDC Project with OHVN/USAID/Mali, Burkina Yatenga Plateau Case Studies:

NOTE: see attached excel spreadsheet with detailed budget.

Case Studies in the Upper Niger River Basin:

Sustainable Livelihoods that Balance Natural Resource Conservation and Agricultural Production in the OHVN Zone and the Yatenga Plateau

A proposal submitted to Mr. Robert Ford, USAID/Global
August 31, 2001

In support of USAID Contribution to the WSSD

By
Larry L. Tieszen, Deputy Manager
International Programs, EROS Data Center, USGS
Sioux Falls, South Dakota, USA 57198

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Case Studies in the Upper Niger River Basin: Sustainable Livelihoods that Balance Natural Resource Conservation and Agricultural Production in the OHVN Zone and the Yatenga Plateau

1. Introduction

The international development community and West African host agencies have cooperated to secure sustainable development in the midst of increasing population pressure and limited natural resources. Such efforts have included working with entrepreneurial farmers investing in systems that generate more secure and prosperous livelihoods and decrease natural resource degradation rates. Recent socioeconomic and biophysical data indicate that farming communities in the OHVN zone (Office de la Haute Vallée du Niger) of southern Mali and on the Yatenga Plateau of northern Burkina show much progress toward sustainable production practices and decreasing environmental degradation (Kelly, 2000; McGahuey, 1998). Information available from field surveys, rapid appraisals, and preliminary remote sensing analyses (OHVN zone) suggest that a significant number of producers are moving from subsistence systems to diversified, revenue-generating systems where yields are increasing and natural resource assets are being maintained. In the OHVN zone, land cover has stabilized since the 1980s, while agricultural production has intensified. Farmers are optimistic about the future, and the youth are remaining in their villages to pursue local economic opportunities. On the Yatenga Plateau, thousands of hectares of degraded and unproductive land have been reclaimed using a variety of soil and crop management techniques (Savadogo et al., 1997; Shaikh et al., 1988; Reij, 2001). These successes shine in contrast to the Sahel Region's general problems of land degradation, loss of vegetation cover and diversity, soil erosion, and increasing human pressure on limited natural resources (Sanou, 1995).

The USGS EROS Data Center, in collaboration with Mali's OHVN (Office de la Haute Vallée du Niger), with support from the USAID/AFR/SD, is currently undertaking a modest effort to monitor and quantify trends in natural and agricultural resources at 8 agricultural communities in the OHVN zone of Mali. Preliminary analysis clearly demonstrates the positive biophysical impact on natural resources that a variety of natural resource management practices have had in the past 10 to 20 years. The approach uses a combination of field surveys, interviews with farmers, and several remote sensing tools that quantify trends in the past 35 to 55 years. The integrated biophysical and socioeconomic approach describes a development story that has resulted in improved economic and environmental conditions.

A parallel field-based study is being initiated in northern Burkina by CONAGESE under the Ministry of Environment, and the PNGIM (Programme National de Gestion de l'Information sur le Milieu). Their objective is to document land rehabilitation efforts to increase land productivity in farming communities on the Yatenga Plateau of northern Burkina (Yatenga, Bam, Sanmatenga, and Zondoma Provinces). In this area, there is anecdotal evidence that millions of hectares that were severely degraded have been rehabilitated using a variety of NRM interventions, and thousands of farmers have worked on soil management techniques that have improved the fertility and crop production in their fields. However, the long-term biophysical trends have not been objectively studied or quantified, nor have the enabling conditions that have led to these improvements.

In both the OHVN zone of Mali and in northern Burkina, anecdotal evidence and preliminary reports show positive trends in land productivity and a stabilization of the natural vegetation cover. This is remarkable given that population pressure on the natural resources has increased over the past several decades (Reardon and Shaikh, 1995; Tappan et al., 2000; Gonzalez, 1997), and a major drought buffeted the region in the 1970's and 1980's (Nicholson, Tucker and Ba, 1998). It is important to quantify the trends for several reasons. From a strategic view point, it is important to show the development community that investments in natural resource management techniques, education, and other programmatic actions have produced tangible results. From an economic view point, it will be valuable to show the results of sustainable land productivity, especially on lands reclaimed from marginal or degraded soils. Furthermore, improved yields and production lessen the pressure to clear new land for cultivation, thus helping to preserve what remains of the natural environment.

2. Scope

The U.S. Geological Survey (USGS) and its EROS Data Center will work closely with partners in West Africa (key partners are OHVN, INSAH, AGRHYMET, CONAGESE, and PNGIM) to monitor, map and quantify trends in land cover, land use, and land productivity from the mid-1960's to the present, focusing on two study

areas: the OHVN Zone of Mali in the Upper Niger River Basin, and the Yatenga Plateau of northern Burkina. This activity constitutes one of four regional studies being conducted in preparation for presentation to the World Summit on Sustainable Development in South Africa, September 2002 (WSSD Working Group, 2001). The focus of this activity is to develop and apply tools to highlight significant positive (and potentially negative) biophysical changes in both study areas, to determine if the agricultural and natural resource conditions in the OHVN and Yatenga areas are statistically different from the trends of the agro-ecological regions adjacent to the focus areas, and to help develop capacity in the region to continue this monitoring effort. The investigators will attempt to relate biophysical trends of the past 35 years to driving factors that include climate, social and economic conditions, demographics, and political processes, capturing and relating the lessons learned over the intervention period. Results will be prepared jointly with all partners, culminating in both detailed reports and electronic presentations for the World Summit on Sustainable Development in South Africa, Septbember 2002. This effort will not only help relate an important story in rural development, it will also demonstrate practical uses of state-of-the-art remote sensing tools that provide synoptic analyses with coarse resolution imagery and detailed, long-term analyses that can be extended to other parts of Africa to capture important natural resource trends over the past 35 or more years.

4. Underlying Questions

The proposed effort will investigate two case study areas in the OHVN Zone of Mali and the Yatenga Plateau of Burkina, building upon the preliminary work by EROS on the OHVN zone, and field research presently being initiated by CONAGESE and PNGIM in Burkina. Specifically, it will operate upon and examine the following hypotheses:

a) farming communities within the OHVN Zone and the Yatenga Plateau exhibit positive trends in natural resource management, agricultural production, and stable natural environment over the past 35 years, despite the pressures of increasing population and periods of drought

b) positive agricultural trends characteristic of the OHVN and Yatenga communities stand in contrast to conditions in surrounding communities which have not benefited as much from the combination of outside intervention and the efforts of local people

c) trends in natural land cover, land use, and land productivity can be monitored and quantified over the past 35 years using the combined strengths of coarse-resolution / high temporal frequency remotely sensed imagery and medium to high resolution imagery, with limited support from field surveys; this approach is feasible and can be replicated across Africa to quantify trends over the past 35 to 40 years

d) biophysical trends in both land use / land cover and agricultural production over the past 35 years can be linked to driving factors including climatic conditions, the macroeconomic context, social changes, demographics, and political processes, providing valuable lessons that can be applied to today's rural development challenges

4. Specific Results

The USGS/EROS Data Center will work with partner institutions (especially OHVN, INSAH, CONAGESE, and PNGIM; other potential partners are FEWS NET, SANREM/CRSP, CILSS, AGRHYMET, ICASA, ICRISAT/IER, French and Dutch researchers), both in the field, and through workshops, to produce five specific results.

Result 1: Expand upon the preliminary geographic analysis of 8 OHVN communities to include at least 12 communities within OHVN and at least 6 communities just outside the OHVN area of intervention, and prepare time-series analyses on each including trends in land use and land cover, assessment of

vegetation cover conditions. A similar number of communities (and their surrounding land, or *terroirs*) will be studied on the Yatenga Plateau. Land use and land cover trends will be mapped and quantified for at least 3 points in time (nominally 1965, 1988, and 2000; some historical aerial photography exists over both areas from 1942); vegetation cover will be qualitatively assessed using medium and high resolution imagery, including low altitude aerial photography. Land use / land cover and vegetation condition trends for each community will be derived independently. Statistical analyses will be performed to determine whether the trends within the OHVN and Yatenga communities are significantly different from those immediately outside of the zones of historical intervention. Limited field surveys will be conducted to assess natural resource and agricultural conditions and practices in the focus areas, and to conduct semi-structured interviews with farmers. In addition, low-cost aerial surveys will be carried out using a light airplane to acquire low altitude, detailed photographs of most or all village territories (*terroirs*) in the focus areas. Each photograph will be geo-referenced using GPS technology. Additional geographic data layers may be incorporated as needed, including datasets prepared by NASA. These will be explored during the course of the year.

Deliverables for Result 1:
a) Produce maps of land use / land cover for key agricultural communities within the focus areas of the OHVN and Yatenga, for the 3 periods in time.

b) Prepare graphs and statistics characterizing the trends in land use / land cover.

c) Conduct a qualitative assessment of changes in vegetation cover over time.

d) Provide ground and aerial photographs acquired in 2001-2002 to key partners, and used in reports and presentations to support conclusions.

e) Prepare a report on statistical analyses of test of significant difference on communities within and outside of intervention zones.

f) Deliver GPS units to key partners involved in field surveys.

Result 2: Prepare Landsat (year 2000) and Corona (year 1965) digital image mosaics of a portion of the Upper Niger River Basin including the OHVN Zone, and the Yatenga Plateau zones (geographically speaking, the latter is not part of the Niger River Basin, but immediately adjacent to it). The mosaics will serve to show the geographic context of the focus areas as well as a large portion of the Upper Niger River Basin, and to illustrate the spatial detail of the imagery. The mosaic will also showcase the historical value of the Corona imagery for long-term studies of this kind. The Corona satellite photographic archive is available over virtually all of Africa, yet its existence and use is hardly known by African

environmental scientists and the international development community. The digital mosaics will also serve to show changes in the land cover and land use over the 35 year period of the study, with numerous focus windows showing specific examples of change. Time permitting, a computer-simulated flight over the study areas will be generate, using the digital image mosaics, creating 3-D views of the landscapes.

Deliverables for Result 2:
a) Landsat digital mosaic using near-current imagery of a portion of the Upper Niger River Basin, with copies provided to key partners in digital and hardcopy formats.

b) Deliver a Corona digital mosaic of a portion of the Upper Niger River Basin representing landscape conditions in the mid-1960's, with copies provided to key partners in digital and hardcopy formats.

c) Prepare a computer-simulation of a flight over the above land areas using the digital image mosaics, if time permits.

Result 3: Analyze land cover productivity using the a vegetation index (NDVI) time-series imagery. The data for this analysis will be derived from historical archives of 8-km and 1-km resolution time-series imagery derived from the NOAA-AVHRR satellite system. The 8-km time-series archive currently spans the period 1982-2000; an 11-year time-series of 1-kilometer resolution image data is currently held at the Regional AGRHYMET Center. This imagery cannot be used in its present form without reprocessing. A separate proposal has been submitted for reprocessing these data in a timely fashion. If reprocessed by early 2002, EROS Data Center scientists will use it to examine land productivity trends in both spatially and temporally within and adjacent to the two focus areas. If the reprocessing is not completed in time, EROS scientists will make use of a 3-year 1-km NDVI archive that currently resides at EROS. Although more restricted in time, a recent analysis of the 3-year NDVI archive over Senegal showed considerable value of this imagery for detecting negative and positive anomalies that were related to low and high vegetation production areas. The analysis will serve to flag and spatially characterize land production anomalies that are indicative of both degradation (poor vegetation production) and significant high production areas that may be attributed to sound NRM practices or natural protected areas. The main products will be land cover performance images, graphs and statistics showing positive and negative production anomalies, and links to supporting imagery and ground data to explain the nature of the main anomalies. As above, farming communities within and outside of the core OHVN and Yatenga Plateau areas will be statistically compared to determine significant differences.

Deliverables for Result 3:
a) Deliver a time-series image database of NDVI 1-km resolution imagery for the Upper Niger River Basin and Yatenga Plateau regions, provided to key partners in digital format.

b) Prepare land cover performance images, graphs and statistics showing positive and negative production anomalies over the study areas.

c) Provide supporting documentation including statistics, ground and aerial photographs that serve to validate the indication of anomalous areas in the NDVI imagery.

Result 4: Conduct and participate in workshops with West African partners in order to prepare and examine the source data, define methodologies, share in the analyses and report on results. Two workshops are anticipated with the OHVN and INSAH in Mali, and at least one workshop is anticipated with the FNGDM and other partners in Burkina. Workshops will be conducted entirely in French. These workshops will also serve to prepare for final presentations of results at the World Summit. Presentations will be prepared in both French and English.

Deliverables for Result 4:
a) Organize and participate in a workshop with the OHVN and INSAH in Mali on data used for natural resource monitoring, methods, analyses, and discussion of results.

b) Participate in a workshop in Burkina with the PNGIM and CONAGESE teams to integrate field research results with analyses of remotely sensed data furnished by the EROS Data Center.

c) Prepare presentation materials in electronic format for the World Summit on Sustainable Development.

Result 5: Initiate ARC-Internet Map Server Capability at AGRHYMET to allow cooperators and other scientists access to the data and a capability to perform on-line queries, analyses, and view detailed maps. We will expand their archive of imagery and facilitate the development of a Clearinghouse and distribution capability in Africa.

Deliverables for Result 5:
a) Formulate specific plans with AGRHYMET to create an on-line query, analysis, and browse system to provide wide access to geographic data and imagery, using ARC-Internet Map Server technology.

b) Deliver to AGRHYMET of the satellite imagery and digital mosaics acquired and prepared under this activity.

c) Begin working with AGRHYMET to implement an on-line query, analysis and browse system. This effort will also be supported by the USAID/West Africa Regional Program through an existing agreement with the USGS.

5. Reports and Web Site

The USGS EROS Data Center will provide USAID/AFR with quarterly reports detailing progress for each of the results. A final report on results will be prepared with input from all partners. Results will also be included in an electronic presentation. French language translation will be provided for all reports and presentation materials. In addition, a web site will be created on this activity to report on progress, to announce workshops, to stage results, and to provide a forum for exchange of ideas. It will be linked to web sites of key partners.

6. References

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Kelly, Valery, 2000, "Measuring the Impacts of Natural Resource Management Activities in the OHVN", Report to USAID/AFR/SD, Washington, D.C.

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Nicholson, S.E., Tucker, C.J., and Ba, M.B., 1998, "Desertification, drought and surface vegetation, an example from the West African Sahel" Bull. Am. Meteorol. Soc., 79, 815-829.

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Reij, C., 2001, personal communication.

Sanou, P., 1995, Farming Pressure on the Land from the Central Plateau to Western Burkina, Master's Thesis, South Dakota State University, 114 pp.

Savadogo, K., T. Reardon, and K. Pietola, 1997, "Adoption of Improved Land-Use Technologies to Increase Food Security in Burkina Faso: Relating Animal Traction, Productivity, and Nonfarm Income", in Agricultural Systems.

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Tappan, G., A. Hadj, E. Wood, and R. Lietzow, 2000, "Use of Argon, Corona, and Landsat Imagery to Assess 30 Years of Land Resource Changes in West-Central Senegal", Photogrammetric Engineering & Remote Sensing, Vol. 66, No. 6, June 2000, pp. 727-735.

WSSD Working Group, 2001, "Geographic Information for Sustainable Development – World Summit on Sustainable Development Geographic Information Working Group Draft Proposed Plan of Action", Draft Report, Washington, D.C.

6. Budget Summary (see attachment for detailed budget)

TOTAL ACTIVITY COSTS

Description	Total
Staffing	$ 70,250
Travel Costs	$ (22,718)**
Data Services/Products	$ 18,702
Other Costs	$ 11,500
Subtotal	$ 123,170
Overhead (39 %)	$ 48,036
GRAND TOTAL	**$ 148,488**

****These travel expenses will be requested from DOS (Department of State) and UNEP to cover and or via the contractor.**

NOTE: The budget for the AGHRYMET/ USGS-EDC activities will be revised downward as understood from recent discussions and confirmed in this email of: Thu 9/6/01 5:43 PM from Larry Tieszen, EROS Data Center, Sioux Falls (see message below).

Dear Bob:

I want to confirm some recent discussions regarding our participation in the Niger Basin project proposed for the WSSD.

The EDC has two separately described but totally interrelated components.
1. The NDVI (1km) preparation project, submitted in its final form by Pat Gonzalez, will be accomplished upon receipt of authorization to expend $100k as desribed in the proposal. This is possible because travel required will be picked up by FEWSNET as needed. If some other source for travel can be secured, this will be helpful.
2. The Land Cover Performance/NRM component, submitted by Gray Tappan, at around $170k, can be accommodated at a reduction to $150k on the assumptions: 1.) that travel to the Sahel from the U.S. can be accommodated from other sources, 2.) travel to South Africa will be provided by other sources as well, and 3.) support for the full participation of our

counterparts (per diem and local travel) can be secured.

Bob, we are pleased to work with you on the resolution of all these issues; however, it is imperative, because of the serial nature of work in this particular project, that funds to initiate work can begin very soon.

Please advise whether our funds will come directly to us as an amendment or via some other means.

Thank you.

Larry.

	Project Summary Page
MOU Lead Implementation Organization	**United States Geological Survey's (USGS) Earth Resources Observation Systems (EROS) Data Center (EDC)**
Contact Person	Mr. Larry L. Tieszen Deputy Manager International Programs EROS Data Center, USGS Sioux Falls, SD 57198, USA Telephone: 605/594-5056 Fax: 605/594-6529 tieszen@edcmail.cr.usgs.gov http://edcintl.cr.usgs.gov/ip
Project/Program and Statement of Work	Target Region 1: Upper Niger Basin: AGRHYMET/FEWS/USGS-EDC **Processing of the AGRHYMET AVHRR and associated NDVI data archive to improve natural resource management and food security in the Sahel.** USGS-EDC, in collaboration with AGRYHMET and FEWS, will develop a consistent and standardized 1990-2001 advanced very high-resolution radiometer (AVHRR) data archive and associated 1 km normalized difference vegetation index (NDVI) data archive to improve natural resource management and food security in the Sahel. NDVI, a satellite-based indicator of green vegetation, is the primary remote sensing tool for tracking environmental change and providing early warning of famine. A description of the activities to be undertaken by USGS-EDC, technical procedures to be followed, deliverables required, and estimated schedule are presented in Attachment 1. Attachment 1 is incorporated as an integral part of this Memorandum of Understanding (MOU).
Collaborating Institutions	AGRHYMET, FEWS
IFDC Contract Number	01600.02
Budget Amount	Signed contract with USGS for $98,200 on 5 Nov 2001
Amendment(s)	Amendment 1 dated March 1, 2002, addressed to Larry Tieszen modified Article 2.2 Finance by shifting line items. No additional funds committed. Amendment 2 dated September 11, 2002, and prepared by Thomas P. Clines modified Articles 2.1 Effective Dates of the MOU and 2.2 Finance. No additional funds committed.
Extension Ending Date	March 31, 2003

IFDC■01600 02

IFDC INTERNATIONAL FERTILIZER DEVELOPMENT CENTER • MUSCLE SHOALS, ALABAMA 35662 USA
P.O. BOX 2040 • 256-381-6600
EMAIL-general@IFDC.org
TELEFAX NO. 256-381-7408

Memorandum of Understanding

Between

International Fertilizer Development Center
PO Box 2040
Muscle Shoals, AL 35662, USA

And

United States Geological Survey's (USGS) Earth Resources Observation Systems (EROS) Data Center (EDC)
Sioux Falls, SD 57198, USA

October 1, 2001

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IFDC01600 02

INTERNATIONAL FERTILIZER DEVELOPMENT CENTER • MUSCLE SHOALS, ALABAMA 35662 USA
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TELEFAX NO. 256-381-7408

Memorandum of Understanding

Between

International Fertilizer Development Center
PO Box 2040
Muscle Shoals, AL 35662, USA

And

United States Geological Survey's (USGS) Earth Resources Observation Systems (EROS) Data Center (EDC)
Sioux Falls, SD 57198, USA

The International Fertilizer Development Center (hereinafter referred to as IFDC) is a public international organization (PIO) dedicated to increasing sustainable agricultural production through the improved use of yield enhancing technologies. The Regional Agroclimatological, Hydrological and Meteorological Institute (AGRHYMET), Famine Early Warning System (FEWS), and USGS-EDC have submitted a proposal to USAID to support development of the AGRHYMET Advanced Very High Resolution Radiometer (AVHRR) and Associated Normalized Difference Vegetation Index (NDVI) data archive to improve natural resource management and food security in the Sahel. In order to carryout the work described herein, IFDC and USGS-EDC hereby agree to the following terms and conditions:

1.0 INTRODUCTION AND STATEMENT OF WORK

The United States Agency for International Development (USAID) has entered into an Agreement with IFDC for IFDC to undertake a project entitled "Quick Start for Agriculture in Africa" to support the Geographic Information for Sustainable Development (GISD) project leading up to the World Summit on Sustainable Development (WSSD).

IFDC will provide USAID EGAD AFS with logistical and management support to the various partners involved in the implementation of the GISD project, including transferring and providing overall fiscal oversight to specific "pass-through" funds to selected partners who are being asked to implement specific GISD activities. This will include work already identified in specific proposals from the NRC, OGC, and several other groups located in the four Target Regions: Upper Niger Basin, African Great Lakes Region, the Kenya-Tanzania Coastal Zone, and the Limpopo/Zambeze River Basin Region of southern Africa.

IFDC will work in close collaboration with the technical officers within USAID providing oversight: Note: The Overall Coordinator is Robert E. Ford, AEMD – Agricultural Enterprise and Market Development Division within USAID's office of Agriculture and Food Security. Robert E. Ford is the Chair of the GISD-IWG for Regional Applications sub-group.

Close coordination must also occur with co-Chairs of the GISD-IWG for each sub-region. They are: Barbara Best (G/ENV) for the Kenya-Tanzania CZM Activity; Paul Bartel and Jon Anderson (AFR-SD) for the Four Corners Limpopo/Zambezi Basin region; Robert Ford for the Great Lakes/Great Horn of Africa Region; and Mike McGahuey (USAID AFR-SD).

USGS-EDC, in collaboration with AGRHYMET and FEWS, will develop a consistent and standardized 1990-2001 advanced very high-resolution radiometer (AVHRR) data archive and associated 1 km normalized difference vegetation index (NDVI) data archive to improve natural resource management and food security in the Sahel. NDVI, a satellite-based indicator of green vegetation, is the primary remote sensing tool for tracking environmental change and providing early warning of famine. A description of the activities to be undertaken by USGS-EDC, technical procedures to be followed, deliverables required, and estimated schedule are presented in Attachment 1, which is incorporated as an integral part of this Memorandum of Understanding (MOU).

BEST AVAILABLE

2.0 SPECIFIC CONDITIONS

2.1 Effective Dates of MOU

The effective dates of this MOU are October 1, 2001-September 30, 2002.

2.2 Finance

The work to be performed under this MOU is being financed by USAID with all funds channeled to IFDC. IFDC shall provide funding to USGS-EDC in accordance with the terms and conditions described in this MOU. USGS-EDC shall develop subagreements as necessary to support funding arrangements and the work to be performed by its collaborating institutions, specifically FEWS and AGRHYMET. The estimated funds available to USGS-EDC total US $98,200 (ninety-eight thousand, two hundred) as follows:

Item	Total US $
Staffing	76,840
Data Services/Products	19,244
Other Costs	2,116
GRAND TOTAL	**98,200**

2.2.1 Use of Funds

IFDC has fiduciary responsibility of funds received from USAID. Under the terms of this MOU, all funds provided to USGS-EDC shall be utilized solely for the purposes indicated in the budget under 2.2. Said funds shall cover all expenditures necessary for the services to be performed by and/or arranged by USGS-EDC. IFDC shall not be responsible for any additional costs (i.e., above US $98,200) incurred in the performance of the work described under this MOU.

2.2.2 Allowable Costs

(a) USGS-EDC shall be reimbursed for costs incurred in carrying out the purposes of this MOU, which are reasonable, allocable, and allowable.

(b) Reasonable shall mean those costs that do not exceed those which would be incurred by an ordinarily prudent person in the conduct of normal business.

(c) Allocable shall mean those costs which are necessary to the MOU.

(d) Allowable shall mean those costs which are reasonable and allocable, and which conform to any limitations set forth in this MOU.

(e) Prior to incurring a questionable or unique cost, USGS-EDC is encouraged to obtain IFDC's written determination as to whether the cost will be allowable.

2.2.3 Payments

IFDC shall make payments to USGS-EDC subject to the receipt of funds from USAID and based upon receipt of an official invoice from USGS-EDC. The invoice may be faxed to the official IFDC Business Contact indicated in 2.6.1. The payments shall be made quarterly on a cost reimbursable basis based upon USGS-EDC'S submission of financial reports, which substantiate costs incurred in the performance of this MOU.

2.2.4 Financial Reports

USGS-EDC shall provide to IFDC a financial report accounting for all allowable costs incurred by USGS-EDC under the program in accordance with the line item budget amounts indicated in 2.2. Copies of documentation to support all costs incurred in performance of work described in this MOU shall be made available to IFDC upon request.

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2.2.5 Audit

USGS-EDC shall maintain books, records, documents, and other evidence in accordance with USGS-EDC's usual accounting procedures to sufficiently substantiate charges to this MOU. IFDC and USAID reserve the right to examine and USGS-EDC agrees to make available all financial records and documents of USGS-EDC as related to this MOU. Any costs that are determined by either IFDC or USAID to be inconsistent with the terms and conditions of this MOU shall immediately be refunded to IFDC. USGS-EDC is subject to the audit guidelines and provisions of 22 CFR Section 226.26. In accordance with the provisions of OMB Circular A-133, USGS-EDC is obligated to comply with the requirements of OMB Circular A-133. USGS-EDC is required to have an audit in full compliance with the guidelines of OMB A-133 and agrees that a copy of the audit report will be submitted to IFDC's supervisor, Accounting Services, by USGS-EDC within thirty (30) days of completion of the audit. By the signing of this MOU, USGS-EDC states that they were informed of, understand, and agree to comply with the applicable compliance requirements.

2.2.6 Refunds

(a) Funds not disbursed to USGS-EDC at the time the MOU expires or is terminated shall revert to IFDC, except for such funds encumbered by USGS-EDC by a legally binding transaction applicable to this MOU. Any funds advanced to but not expended by USGS-EDC at the time of expiration or termination of the MOU shall be refunded to IFDC except for such funds encumbered by USGS-EDC by a legally binding transaction applicable to this MOU.

(b) If, at any time during the life of the MOU, or as a result of final audit, it is determined that funds provided under this MOU have been expended for purposes not in accordance with the terms of this MOU, USGS-EDC shall refund such amount to IFDC.

2.3 Language

The MOU has been executed in English, which shall be the binding and controlling language for interpretation of the terms and conditions of this MOU.

2.4 Subagreements

It is understood that USGS-EDC may carryout the work described under this MOU in collaboration with others. It is further understood that funds provided to USGS-EDC may be used to support work carried out by collaborating institutions. USGS-EDC shall ensure that the specific conditions of this MOU (i.e., Section 2.0, Specific Conditions) shall apply to all such subagreements.

2.5 Revision of MOU Budget

(a) The approved MOU budget is the financial expression of USGS-EDC's program.

(b) USGS-EDC shall immediately request approval from IFDC when there is reason to believe that within the next 30 calendar days a revision of the approved MOU budget will be necessary for any of the following reasons:

- To change the scope or the objectives of the program and or revise the funding allocated among objectives by more than ten percent of the total budget amount unless the schedule states otherwise.
- Additional funding is needed.
- USGS-EDC expects the amount of authorized funds to exceed its needs by more than $5,000 or five percent of the MOU budget, whichever is greater.

(c) Except as required by other provisions of this MOU specifically stated to be an exception from this provision, IFDC shall not be obligated to reimburse USGS-EDC for costs incurred in excess of the total amount obligated under the MOU. USGS-EDC shall not be obligated to continue performance under the MOU (including actions under the "Termination Procedures" provision) or

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otherwise to incur costs in excess of the amount obligated under the MOU, unless and until IFDC has notified USGS-EDC in writing that such obligated amount has been increased and has specified the new MOU total amount.

2.6 Other Terms and Conditions

The following terms and conditions, which are applicable to the MOU by and between USAID and IFDC, shall be integral part of this Agreement.

2.6.1 Official Contacts

The contacts under this MOU for all official contacts are as follows:

IFDC Technical
Dr. Lawrence L. Hammond
Director, Research and Development Division
IFDC
PO Box 2040
Muscle Shoals, AL 35662, USA
Telephone: 256/381-6600, extension 270
FAX: 256/381-7408
lhammond@ifdc.org
www.ifdc.org

IFDC Business
Mr. John H. Allgood
Director, Finance, Administration, and Support Services
IFDC
PO Box 2040
Muscle Shoals, AL 35662, USA
Telephone: 256/381-6600, extension 211
FAX: 256/381-7408
jallgood@ifdc.org
www.ifdc.org

USGS-EDC Technical Business
Mr. Larry L. Tieszen
Deputy Manager
International Programs
EROS Data Center, USGS
Sioux Falls, SD 57198, USA
Telephone: 605/594-5056
Fax: 605/594-6529
tieszen@edcmail.cr.usgs.gov
http://edcintl.cr.usgs.gov/ip

2.6.2 Publications and Media Releases

If it is USGS-EDC's intention to identify USAID's contribution to any publication, video or other information media product resulting from this MOU, USGS-EDC shall state that the views expressed by the author(s) do not necessarily reflect those of USAID. Acknowledgements should identify the sponsoring USAID Office and Bureau or Mission as well as USAID substantially as follows:

"This [publication, video or other information media project (specific)] was made possible through support provided by the Center for Economic Growth and Agricultural Development, Office of Agriculture and Food Security, under the terms of the MOU. The opinions expressed herein are those of the author(s) and do not necessarily reflect the views of USAID."

USGS-EDC shall provide the relevant strategic objective or results package team with one copy of all published works developed under this MOU and with lists of other written work produced under the MOU.

Except as otherwise provided in the terms and conditions of the MOU, the author or USGS-EDC is free to copyright any books, publications, or other copyrightable materials developed in the course of or under this MOU, but USAID reserves a

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royalty-free nonexclusive and irrevocable right to reproduce, publish, or otherwise use, and to authorize others to use the work for U.S. Government purposes.

2.6.3 Reports and Data

USGS-EDC shall send to the IFDC Technical Contact at the address included in this MOU, monthly and quarterly progress reports in a form and substance satisfactory to IFDC. The monthly reports will provide a brief report on the status of activities being undertaken to implement this project during the previous 30 days.

The quarterly reports shall indicate progress toward achieving Program objectives and implementing approved work plans. The reports shall include, but not be limited to, the following information:

- Status of achievement of program goals, objectives, and benchmarks specified in the annual work plan
- Progress or completion of components, elements, or activities against planned targets
- Program description
- Other accomplishments or program highlights
- Identification and explanation of significant problems which have been encountered
- Description of planned corrective action

The monthly and quarterly reports may be submitted in electronic format and are to be delivered to IFDC within 7 calendar days and 20 calendar days, respectively, of the end of the reporting period. A final report addressing the same components included in the quarterly report is to be submitted to IFDC by USGS-EDC within 45 calendar days of the ending date of this MOU. The reports submitted to USGS-EDC to IFDC and supporting materials compiled in performing the services shall be the property of USAID.

USGS-EDC is also required to submit copies of reports publications, produced within each activity as requested by the USAID Cognizant Technical Officer (e.g., workshop proceedings, PowerPoint presentations, etc.).

2.6.4 Termination

This agreement may be terminated, in whole or in part, by either party at any time upon 30 days written notice of termination. Upon receipt of and in accordance with a termination notice from the IFDC, the USGS-EDC shall take immediate action to cease all expenditures financed by this MOU and to cancel all unliquidated obligations if possible. Further, upon receipt of notice of termination, the USGS-EDC shall not enter into any further obligations under this MOU. Except as provided below, no further reimbursement shall be made after the effective date of termination. The USGS-EDC shall within 30 days of the effective date of termination repay to IFDC all unexpended funds that are not otherwise obligated by a legally binding transaction applicable to this MOU. Should the funds paid by IFDC to the USGS-EDC prior to the effective date of termination be insufficient to cover the USGS-EDC's obligations in a legally binding transaction, the USGS-EDC may submit to IFDC within 90 days after the effective date of termination a written claim for such amount. The IFDC shall determine the amount(s) to be paid by IFDC to the USGS-EDC under such claim in accordance with the "Allowable Costs" provision of this MOU.

2.6.5 Dispute Settlement

Because of the nature of this agreement and the legal status of the respective organizations engaged under this MOU, reconciliation of disputes which cannot be handled amicably will be settled through discussions negotiations by and between the signatories to the MOU.

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2.6.6 Investment Promotions

No funds or other support provided hereunder may be used in a program or activity reasonably likely to involve the relocation or expansion outside of the United States of an enterprise located in the United States if non-US production in such relocation or expansion replaces some or all of the production of, and reduces the number of employees at, said enterprise in the United States.

No funds or other support provided hereunder may be used in a program or activity the purpose of which is the establishment or development in a foreign country of any export processing zone or designated area where the labor, environmental, tax, tariff, and safety laws of the country would not apply, without the prior written approval of IFDC.

No funds or other support provided hereunder may be used in an activity which contributes to the violation of internationally recognized rights of workers in the recipient country including those in any designated zone or area in that country. This provision must be included in all subagreements.

2.6.7 Non-Liability

IFDC does not assume liability for any third party claims for damages arising out of this MOU.

2.6.8 Notices

Any notice given by either party under this MOU shall be sufficient only if in writing and delivered in person or faxed to the official contact persons identified in 2.5.1

2.6.9 Special Provisions

USGS-EDC shall comply with USAID environmental regulations (22 CFR Section 216 "Regulation 16") with respect to the activities to be undertaken under this MOU.

2.6.10 Procurement Policies and Procedures

Because USAID is the sole contributor, USAID procurement policies and procedures are applicable (22 CFR Section 226 and ADS 308.5.7a).

2.6.11 Ineligible Countries

Activities under this agreement may only be carried out in countries that are eligible to receive assistance under the Foreign Assistance Act. USGS-EDC shall provide IFDC in advance a list of those countries where activities are planned under this MOU.

2.6.12 Entire MOU

Unless otherwise specified, this MOU embodies the entire understanding between IFDC and USGS-EDC for the services to be provided and any prior to contemporaneous representations, either oral or written, are hereby superseded. No amendments or changes to this MOU, including, without limitation, changes in the statement of work, total estimated cost, and period of performance, shall be effective unless made in writing and signed by authorized representatives of the parties.

FOR AND ON BEHALF OF IFDC	FOR AND ON BEHALF OF USGS-EDC
By: [signature]	By: [signature]
Name: JOHN H. AUGUD	Name: BARBARA J. RYAN
Title: DIRECTOR FASSU	Title: Associate Director, Geography
Date: NOV 5, 2001	Date: Dec. 5, 2001

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WITNESS:

By: LHammond

Name: LAWRENCE HAMMOND

Title: Director, R+D

Date: 5 NOV 2001

WITNESS:

By: Robert A. Lidwin

Name: Robert A. Lidwin

Title: Chief of Staff

Date: 12-05-01

DRAFT PROPOSAL DRAFT PROPOSAL

III. Workplans submitted by sub-activity partners:

A. Target Region 1: Upper Niger Basin:

AGRYHMET / FEWS /USGS-EDC Project with Patrick Gonzalez (USAID/AFR-SD) as lead:

Processing of the AGRHYMET Advanced Very High Resolution Radiometer (AVHRR) and associated Normalized Difference Vegetation Index (NDVI) data archive to improve natural resource management and food security in the Sahel
activity proposal EROS Data Center, U.S. Geological Survey (USGS)
Centre Régional AGRHYMET, Comité Permanent Inter-États de Lutte Contre la Sécheresse dans le Sahel (CILSS)

April 27, 2001

Technical Team

Larry L. Tieszen	Deputy Manager, International Program, EROS Data Center, USGS <tieszen@usgs.gov>
Jim Rowland	Senior Scientist, EROS Data Center <rowland@usgs.gov>
Alfari Issoufou	Chef de l'Unité SIG-Télédétection, Centre Régional AGRHYMET, Niamey, Niger <alfari@sahel.agrhymet.ne>
Patrick Gonzalez	Desertification and Climate Change Advisor EROS Data Center, USGS Bureau for Africa, U.S. Agency for International Development (USAID) <pgonzalez@usgs.gov>, <pgonzalez@usaid.gov>

Support to USAID Strategic Objectives

AFR/SD IR 22.3	"Improved famine prevention, drought preparedness, and adoption of response plans," managed by Will Whelan
AFR/SD SO 17	"Accelerate progress in the spread of strategically viable and environmentally sound environmental management systems," environmental monitoring activities managed by Paul Bartel
G/EGAD SO 2	"Improved food availability, economic growth, and conservation of natural resources through agricultural development," soil carbon activity managed by Bob Ford
WARP SO 3	"The development and implementation of policies that promote sustainable food security and environmental/natural resources management are improved in West Africa," AGRHYMET activities managed by Rod Kite

Summary

This document requests funding for a joint effort to develop a consistent and standardized 1990-2001 AVHRR data archive and associated 1 km NDVI products for the West African Sahel at the Centre Régional AGRHYMET. NDVI, a satellite-based indicator of green vegetation, is the primary remote sensing tool for tracking environmental change and providing early warning of famine. Recognizing the inconsistent quality of the AGRHYMET NDVI data set, the Director-General of AGRHYMET first requested assistance from USGS and USAID in 1999. Correction of the NDVI archive and improvement of operational NDVI capabilities would permit AGRHYMET to fulfill its mission of providing scientifically sound environmental monitoring services for the nine CILSS member countries.

This capacity-strengthening activity would contribute to the implementation of and advance collaboration among strategic objectives of three USAID operating units: the Bureau for Africa Office for Sustainable

Development (USAID/AFR/SD), the Bureau for Global Programs Center for Economic Growth and Agricultural Development (USAID/G/EGAD), and the West Africa Regional Program (USAID/WARP).

Background

People in the West African Sahel subsist on the limited natural resources of the region's arid ecosystems. Declines in land productivity due to desertification and climate change have further increased the vulnerability of people in the Sahel over time. The remote sensing of natural resources provides tools to assess these problems and to develop effective solutions.

AGRHYMET is the remote sensing center for the nine West African member states of CILSS. With USAID funding in the late 1980s and early 1990s, the USGS EROS Data Center helped build the capacity of AGRHYMET to process, analyze, and apply remote sensing data to natural resource management and food security issues. The primary remote sensing product that AGRHYMET uses is NDVI, calculated from Advanced Very High Resolution Radiometer (AVHRR) data that AGRHYMET downloads directly from the polar orbiting series of National Oceanic and Atmospheric Administration (NOAA) satellites. Since 1990, AGRHYMET has processed AVHRR data, calculated NDVI at 1 km resolution for ten-day composite periods, produced maps that show the progress of the agricultural growing season, and distributed the NDVI maps to national AGRHYMET centers. Over time, NDVI can also reveal areas of longer-term environmental change.

USGS staff have examined the existing 1 km resolution NDVI archive and identified fundamental technical problems:

1. *Imprecise geographic registration*—geographic registration with only a handful of tie points has produced images that may be up to 5 pixels off, as identified by the coastline
2. *Incorrect spatial compositing*—some images are incorrectly assembled
3. *Temporal gaps*—the series omits many time periods, with only the growing season covered in most years
4. *Low values*—NDVI values throughout images through the entire time period are extremely low, probably because of incomplete calibration

These problems place the accuracy of AGRHYMET famine early warning information and the institution's scientific credibility at risk.

Confronted by similar, but less serious, problems in the 1981-2001 8 km resolution NDVI data archive for Africa, the National Aeronautics and Space Administration re-processed that data series. USGS EROS Data Center has posted the re-processed 8 km NDVI data for public access at <http://edcintl.cr.usgs.gov/adds>. The correction of the 8 km NDVI data has made possible the comparison of current with historical ten-day NDVI for famine early warning and the calculation and analysis of time-integrated NDVI over the agricultural season in Senegal. Integration of NDVI over time produces an index of cumulative green biomass production, permitting an analysis of possible patterns of climate or human-induced environmental change.

High-resolution 1 km NDVI data are 64 times more detailed than the coarse-resolution 8 km NDVI series. For that reason, AGRHYMET continues to process and distribute maps of 1km NDVI, despite the technical problems described above.

Correction of the 1km NDVI data series would advance the implementation of four activities funded by USAID, three of those implemented by USGS, that use NDVI and that work to strengthen capacity at AGRHYMET:

1. *Famine Early Warning System Network (FEWS NET)*, funded by AFR/SD—FEWS NET uses USGS expertise to assist AGRHYMET and its national centers to analyze NDVI and to provide remote sensing information to food security specialists. FEWS NET has stationed a USGS scientist at AGRHYMET, Dr. Alkhaili Adoum from Chad, to provide on-site technical assistance.
2. *Land Cover Performance (LCP) activity*, funded by AFR/SD—For the LCP activity, USGS is smoothing the highly variable 8 km resolution NDVI time series for three windows in East, Southern, and West Africa and time-integrating the smoothed NDVI over agricultural seasons. In conjunction with analyses of rainfall data, the seasonally-integrated NDVI can assist in assessing the factors involved in environmental change.

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3. *Carbon sequestration activity*, funded by AFR/SD and G/EGAD—This activity works to build the capacity of specialists from AGRHYMET and other remote sensing centers to measure and market carbon sequestered in agricultural soils. Carbon sequestration activities restore soil organic matter and enhance fertility, serving both to mitigate climate change and to improve human livelihoods.
4. *Support to AGRHYMET*, funded by WARP—Support to AGRHYMET seeks to further develop the center's capacities for assessing regional food security and vulnerability.

Therefore, the proposed recovery of the AGRHYMET NDVI archive would provide multiple benefits to AGRHYMET. The corrected 1 km NDVI archive would improve the early warning information that AGRHYMET routinely distributes. Moreover, the corrected archive would allow AGRHYMET to undertake a high-resolution analysis of time-integrated NDVI, possibly revealing patterns of environmental change. In the future, a long-term NDVI archive will permit AGRHYMET to conduct detailed analyses of desertification, one of its obligations under the U.N. Convention to Combat Desertification (UNCCD). Finally, the training of AGRHYMET staff and the experience that they gain through the NDVI reprocessing will give them the capability to maintain the integrity of the data that they continue to process every ten days.

Technical procedures

Reprocessing of the original AVHRR data using Land Analysis System (LAS) software installed at AGRHYMET can correct most of the identified problems in the NDVI archive. USGS will assist AGRHYMET with increasing the number of tie points for proper geographic registration and provide current ephemeris data, necessary information on the rotation and shape of the earth. Concerning the temporal gaps, ten-day averages may help fill some of them, although others may remain if AGRHYMET did not maintain the original AVHRR data. To correct the low NDVI values, NASA will provide calibration coefficients for proper inter- and intra-sensor calibration, and to correct for volcanic ash and other atmospheric anomalies.
AGRHYMET staff will conduct the computer processing with on-site assistance from USGS and NASA staff. Once processed, USGS will assist AGRHYMET with validating the accuracy of the data. AGRHYMET and USGS will evaluate web site access.

Deliverables

1. NDVI time series
   a. time period: May 1990-present; possible gaps in 1994, 1996, and 1999
   b. temporal resolution: 10 days
   c. spatial resolution: 1 km
   d. spatial extent: 20°W – 26°E longitude, 4°N-28°N latitutude
   e. projection: geographic
   f. NDVI value range: [0, 255] or [0, 200]
   g. calibration: corrected for NOAA satellite sensor degradation and inter-sensor differences; corrected for atmospheric effects, including ash from El Chichon and Mt. Pinatubo volcanic events
2. Federal Geographic Data Committee metadata
3. Written report documenting the work

Estimated Schedule

Reprocessing the AGRHYMET NDVI archive (1990-2001) should require approximately 6 months total labor time and approximately 1 full-time equivalent (FTE) during that period.

Proposed Budget

USGS senior scientist, 0.30 full time equivalent (FTE)	$37 500	
USGS scientist, 0.12 FTE	$10 300	
AGRHYMET scientist, 6 months	$9000	
NASA scientist, 2 weeks	$4800	
U.S.—Niger travel, 3 trips, 15 days each	**($15 000)*** **	
AGRHYMET computer hard drive – 100 Gb		$2000
total direct costs:	$78 600	
USGS overhead (46%)	$36 200	
Total	**$98,200**	

*****This travel will be requested from other entities, e.g. DOS/UNEP/FEWS. See Note below:**

NOTE: The budget for the AGHRYMET/ USGS-EDC activities will be revised downward as understood from recent discussions and confirmed in this email of: Thu 9/6/01 5:43 PM from Larry Tieszen, EROS Data Center, Sioux Falls.

Dear Bob:

I want to confirm some recent discussions regarding our participation in the Niger Basin project proposed for the WSSD.

The EDC has two separately described but totally interrelated components.
1. The NDVI (1km) preparation project, submitted in its final form by Pat Gonzalez, will be accomplished upon receipt of authorization to expend $100k as desribed in the proposal. This is possible because travel required will be picked up by FEWSNET as needed. If some other source for travel can be secured, this will be helpful.
2. The Land Cover Performance/NRM component, submitted by Gray Tappan, at around $170k, can be accommodated at a reduction to $150k on the assumptions: 1.) that travel to the Sahel from the U.S. can be accommodated from other sources, 2.) travel to South Africa will be provided by other sources as well, and 3.) support for the full participation of our counterparts (per diem and local travel) can be secured.

Bob, we are pleased to work with you on the resolution of all these issues; however, it is imperative, because of the serial nature of work in this particular project, that funds to initiate work can begin very soon.

Please advise whether our funds will come directly to us as an amendment or via some other means.

Thank you.

Larry.

P.O. Box 2040
Muscle Shoals, Alabama 35662
U.S.A.
Telephone: +1 256 381-6600
Telefax: +1 256 381-7408
E-Mail: general@ifdc.org
Web Site: www.ifdc.org

An International Center for Soil Fertility and Agricultural Development • Un Centro Internacional de Fertilidad del Suelo y Desarrollo Agrícola • Un Centre international pour la Fertilité des Sols et le Développement Agricole

March 1, 2002

ACIS Ref ID: 7035

Mr. Larry L. Tieszen
Deputy Manager
International Programs
EROS Data Center, USGS
Sioux Falls, SD 57198

Amendment Number 1 to MOU between IFDC and United States Geological Survey's (USGS) Earth Resources Observation Systems (EROS) Data Center (EDC) for Development of the AGRHYMET AVHRR and NCV1 Data Archive

This document will serve as Amendment 1 to the above-mentioned MOU. The parties to this MOU agree to the following modification to the above-mentioned MOU.

2.2 Finance

The work to be performed under this MOU is being financed by USAID with all funds channeled to IFDC. IFDC shall provide funding to USGS-EDC in accordance with the terms and conditions described in this MOU. USGS-EDC shall develop subagreements as necessary to support funding arrangements and the work to be performed by its collaborating institutions, specifically FEWS and AGRHYMET. The estimated funds available to USGS-EDC total US $98,200 (ninety-eight thousand, two hundred) as follows:

Item	Total US $
Staffing	57,540
Data Services Products	17,244
AGRHYMET SUN Processing System	11,000
Other Costs	2,116
GRAND TOTAL	98,200

This budget modification is made to specifically allow for the following:

- Incorporate cost of AGRHYMET SUN Processing System ($11,000)
- Remove AGRHYMET scientist ($9,000)
- Remove AGRHYMET computer hard drive ($2,000)

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Mr. Laksiri Abeysekera
March 1, 2002

The AGRHYMET Regional Center will provide the necessary human resources to fulfill the needs as indicated in the original MOU dated October 1, 2001.

All the terms and conditions of the MOU by and between IFDC and USGS-EDC shall remain in full force and effect.

Please return one signed copy of this Amendment to IFDC.

Sincerely yours,

BY
DIRECTOR OF ADMINISTRATION
for
Amit H. Roy
President and Chief Executive Officer

ACCEPTED AND AGREED TO:

USGS-EDC

Amendment Number 2
to
MOU (ACIS #6804) between IFDC
and
United States Geological Survey (USGS) Earth Resources Observation Systems (EROS) Data Center (EDC)
for
Development of the AGRHYMET AVHRR and NDVI Data Archive

The parties to the above-mentioned MOU agree to the following modifications:

2.1 Effective Dates of MOU

The effective dates of this MOU are October 1, 2001-March 31, 2003.

2.2 Finance

The work to be performed under this MOU is being financed by USAID with all funds channeled to IFDC. IFDC shall provide funding to USGS-EDC in accordance with the terms and conditions described in this MOU. USGS-EDC shall develop sub-agreements as necessary to support funding arrangements and the work to be performed by its collaborating institutions, specifically FEWS and AGRHYMET. The estimated funds available to USGS-EDC total US $98,200 (ninety-eight thousand, two hundred) as follows:

Item	Total US $
Staffing	55,540
Travel Costs (U.S.-Africa x 15 days)	12,000
Data Services Products	17,244
AGRHYMET SUN Processing System	11,000
Other Costs	2,116
GRAND TOTAL	**98,200**

This modification of the effective dates of the MOU and the rearrangement of the budget are made to specifically allow for the following:

1. Delays in project initiation (including travel to AGRHYMET Center in Niamey, Niger) due to events of September 11, 2001;
2. Change in processing methods to allow commercial programming capability, and independence from non-commercial software;
3. Quality control and follow-up work during and after the historical processing period for the 12-year archive (approximately 3.5 months to process historical AVHRR data with the current Sun workstation);

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Amendment Number 2
to
MOU (ACIS #6804) between IFDC
and
United States Geological Survey (USGS) Earth Resources Observation Systems (EROS) Data Center (EDC)
for
Development of the AGRHYMET AVHRR and NDV1 Data Archive

The parties to the above-mentioned MOU agree to the following modifications:

2.1 Effective Dates of MOU

The effective dates of this MOU are October 1, 2001-March 31, 2003.

2.2 Finance

The work to be performed under this MOU is being financed by USAID with all funds channeled to IFDC. IFDC shall provide funding to USGS-EDC in accordance with the terms and conditions described in this MOU. USGS-EDC shall develop sub-agreements as necessary to support funding arrangements and the work to be performed by its collaborating institutions, specifically FEWS and AGRHYMET. The estimated funds available to USGS-EDC total US $98,200 (ninety-eight thousand, two hundred) as follows:

Item	Total US $
Staffing	55,840
Travel Costs (U.S.-Africa x 15 days)	12,000
Data Services/Products	17,244
AGRHYMET SUN Processing System	11,000
Other Costs	2,116
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This modification of the effective dates of the MOU and the rearrangement of the budget are made to specifically allow for the following:

1. Delays in project initiation (including travel to AGRHYMET Center in Niamey, Niger) due to events of September 11, 2001;
2. Change in processing methods to allow commercial programming capability, and independence from non-commercial software;
3. Quality control and follow-up work during and after the historical processing period for the 12-year archive (approximately 3.5 months to process historical AVHRR data with the current Sun workstation);

4. Implementation of updated algorithms currently being developed at NASA to provide improved calibration between NOAA-16 and archival NOAA-14 and NOAA-11 data.
5. Operational review of corrected 12-year archive for the implementation of applications in the Sahel.

All other terms and conditions of the MOU by and between IFDC and USGS-EDC shall remain in full force and effect.

FOR AND ON BEHALF OF IFDC:

11-8-02

John H. Allgood — Date
Director, FASSO
BY DIRECTOR OF ADMINISTRATION

FOR AND ON BEHALF OF USGS-EDC:

5 Sept. 02

Barbara J. Ryan — Date
Associate Director, Geography

	Project Summary Page
MOU Lead Implementation Organization	**United States Geological Survey's (USGS) Earth Resources Observation Systems (EROS) Data Center (EDC)**
Contact Person	Mr. Larry L. Tieszen Deputy Manager International Programs EROS Data Center, USGS Sioux Falls, SD 57198, USA Telephone: 605/594-5056 Fax: 605/594-6529 tieszen@edcmail.cr.usgs.gov http://edcintl.cr.usgs.gov/ip
Project/Program and Statement of Work	World Wildlife Fund (WWF) GIS Strategy for Southern Africa. **Development of a data documentation and discovery system**. Explore options for applying available remotely sensed data to environmental monitoring and conservation planning. USGS-EDC, in collaboration with WWF, will guide WWF through the process of documenting their geospatial data holdings using the draft ISO metadata standard and providing access to metadata records via metadata clearinghouse technology. EDC also will explore options for applying available remotely sensed data to environmental monitoring and conservation planning to strengthen existing WWF activities.
Collaborating Institutions	World Wildlife Fund (WWF)
IFDC Contract Number	01617/02
Budget Amount	Signed contract with WWF for $50,000 on March 27, 2002
Amendment(s)	Amendment 1 dated June 12, 2002, to Thomas Clines provided an additional $20,000. Amendment 2 dated November 18, 2002, to Larry Tieszen provided an additional $30,000.
Extension Ending Date	

ACIS Ref ID: 7279

IFDC INTERNATIONAL FERTILIZER DEVELOPMENT CENTER • MUSCLE SHOALS ALABAMA 35662 USA
P.O. BOX 2040 • 256-381-6600
EMAIL-general@IFDC.org
TELEFAX NO. 256-381-7408

June 12, 2002

Mr. Thomas P. Clines
Office of Partnerships and Business Policy
Branch of External Coordination
U.S. Geological Survey, MS 500
12201 Sunrise Valley Drive
Reston, VA 20192

Dear Mr. Clines:

Amendment Number 1 to MOU between IFDC and United States Geological Survey's (USGS) Earth Resources Observation Systems (EROS) Data Center (EDC) to support the World Wildlife Fund (WWF) GIS Strategy for Southern Africa

This document will serve as Amendment 1 to the MOU between IFDC and USGS EROS Data Center in which the IFDC will provide an additional $20,000 to augment EDC's support to GISD/WSSD Southern Africa activities, as well as complementary activities for Africa as a whole. The additional funds provided under this amendment shall be used to fund activities in accordance with the line item budget below:

Budget To Support GISD/WSSD Southern Africa Activities

Cost Categories	Amount
Staffing	$14,134
Overhead	$5,866
Total Amount provided under this Amendment	$20,000

EDC's support includes networking among GISD alliance partners, building awareness about technical and institutional frameworks for data sharing and data integration, and strengthening communication among partners to achieve GISD objectives. Maintaining the flow of information between partners is critical in reinforcing the community of geospatial technology practitioners brought together through the GISD alliance.

EDC will undertake the following activities:

1. EDC will continue to respond to requests from GISD partners and follow up on items discussed during the GISD partners' meetings in Bamako, Eritrea and Nairobi.
2. EDC will liaison with partners with respect to data sources, data standards, data access mechanisms, and opportunities for partnerships and training.

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Mr. Thomas P. Clines
June 12, 2002

3. EDC will contribute content pertinent to the GISD website and any compact discs which may be produced.
4. EDC will work with USAID, U.S. Department of State, EIS-Africa, ECA-CODI, UNEP, and others in the GISD alliance to ease the transition of GISD to post-WSSD by building a common vision for spatial data infrastructure.
5. EDC expects that travel in the amount of $5000 will be provided by IFDC in support of these activities.

All the terms and conditions of the MOU by and between IFDC and USGS-EDC shall remain in full force and effect.

Sincerely yours,

Amit H. Roy
President and Chief Executive Officer

ACCEPTED AND AGREED TO:

USGS

PROJECT DATA SHEET

PROJECT NAME: Subcontract - USGS with regard to the GISD Pjt.	**CONTRACT NUMBER:** **IFDC Contract #:** 01617/02 A2 **Donor's #:**	**COUNTRY:** AFRICA
FUNDING AGENCY/CLIENT: Subcontractor: USGS Prime: IFDC/USAID for GISD/WSSD	**CONTRACT AMOUNT:** $30,000 **Initial Obligated Amt:** $20,000 Total Contract: $100,000	**PAYMENT METHOD:** L/C ☐ Check ☒ Direct Deposit ☐ Payable by IFDC
START DATE (month/year): February 15, 2002	**COMPLETION DATE (month/year):** September 30, 2002	**AMENDMENT NUMBER (if any):** A2
TECHNICAL REPRESENTATIVE OF FUNDING AGENCY Name: Mr. Larry Tieszen Deputy Manager Address:International Programs EROS Data Center, USGS Sioux Falls, SD 57198 Phone: Fax: Email:	**CONTRACT OFFICER/GRANT OFFICER** Name: Mr. Thomas P. Clines Email: tclines@usgs.gov Address: U.S. Geological Survey Reston, Virginia 20192 Phone: 703-648-5481 Fax: 703-648-4642	**IFDC DIVISION RESPONSIBLE FOR TECHNICAL REPORT** MDD ☐ RDD ☒ IFDC/AFRICA ☐

OBJECTIVE:

PROJECT DESCRIPTION:

TECHNICAL DELIVERABLES

Report Type:	Frequency:	Due Dates:	Responsible IFDC Staff:
1 Progress Report	1.Monthly	1.Within 7 days	L. Hammond
2.Progress Report	2.Quarterly	2.Within 20 days	
3.Final Report	3.one	3.Within 45 days	
4.	4.	4.	
5.	5.	5.	

FINANCIAL DELIVERABLES

Report Type:	Frequency:	Due Dates:	Responsible IFDC Staff:
1.Invoices	1.Monthly	1.	D. Shedd
2.Financial Report	2.Monthly	2.Within 20 days	
3.	3.	3.	
4.	4.	4.	
5.	5.	5.	

OTHER DELIVERABLES

Report Type:	Frequency:	Due Dates:	Responsible IFDC Staff:
1.	1.	1.	
2.	2.	2.	

ACIS Ref. # 7533

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TELEFAX NO. 256-381-7408

November 18, 2002

Mr. Larry L. Tieszen
Deputy Manager
International Programs
EROS Data Center, USGS
Sioux Falls, SD 57198

Dear Mr. Tieszen:

Amendment Number 2 to MOU between IFDC and United States Geological Survey's (USGS) Earth Resources Observation Systems (EROS) Data Center (EDC) to support the World Wildlife Fund (WWF) GIS Strategy for Southern Africa

IFDC and USGS-EDC hereby agree to following terms and conditions of Amendment 1 to the MOU dated February 15, 2002. IFDC will provide an additional $30,000 to augment EDC's support to GISD and continuing WSSD activities, including GISD related activities emanating from the GASSIA workshop.

EDC's support includes networking among GISD alliance partners, building awareness about technical and institutional frameworks for data sharing and data integration, and strengthening communication among partners to achieve GISD objectives. EDC also provides the direct consultant expertise needed to establish servers and metadata-based clearinghouses that are being constructed by partnerships which have developed.

Section 1.0 Introduction and Statement of Work will be modified to include the following EDC activities:

1. Provide consultant expertise to CGIAR and GISD partners in the development of OpenGIS map services and associated metadata.
2. Provide technical assistance to CGIAR and GISD partners in the establishment of the above web services including compliance testing on available services.
3. Continue discussions of technical specifications with OGC and FGDC.
4. Develop technical instructions for the establishment of integrated metadata and map servers.

5. Co-author and maintain the Africa SDI Guide and website. Encourage GISD colleagues to contribute material. Prepare Africa SDI Guide and website and have available for review by end of year. Prepare for 'Experts Meeting' tentatively scheduled for February 2003.
6. Compile information about data standards, data sources, data access policies, SDI institutional development, funding mechanisms, RS GIS applications, training opportunities, and geospatial projects initiatives in Africa, and circulate via the SDI Africa Newsletter and GISD website.
7. Help with GISD coordination, provide support for the Forum and GISD alliance, and contribute to GISD publications, projects, workshops, and meetings.
8. Begin to co-design CGIAR-CSI geospatial demonstration project for World Water Summit.
9. Work with Intergraph and OGC on outreach and training in Africa in conjunction with the Intergraph interoperability grant program. Through this program, core datasets will be made available through map services in Africa. Also, support SISEI and OGC in the incorporation of metadata, map services and other SDI components into its program.

2.2 Finance

The estimated funds available to USGS-EDC shall be increased by $30,000 as follows:

Item		Total US $
Staffing		
Information System Policy Expert	(6 weeks)	10,800
Internet IT Expert	(4 weeks)	9,300
Travel Costs		2,000
Data Services Products		
Overhead		[illegible]
GRAND TOTAL		**30,000**

Of the total amount estimated to be available to USGS-EDC under this Amendment, the obligated amount shall be $20,000. Should additional funds be made available to IFDC, then the obligated amount may be further increased.

All the terms and conditions of the MOU by and between IFDC and USGS-EDC shall remain in full force and effect.

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Mr. Larry L. Tieszen
November 18, 2002

Please return one signed copy of this Amendment to IFDC.

Sincerely yours,

Jah H Allgood for A. H. Roy

Amit H. Roy
President and Chief Executive Officer

ACCEPTED AND AGREED TO:

Robert A. Lindner

USGS-EDC

ACIS Ref ID: 7574

IFDC INTERNATIONAL FERTILIZER DEVELOPMENT CENTER • MUSCLE SHOALS, ALABAMA 35662 USA
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TELEFAX NO. 256-381-7408

January 6, 2003

Mr. Larry L. Tieszen
Deputy Manager
International Programs
EROS Data Center, USGS
Sioux Falls, SD 57198

Dear Mr. Tieszen:

Amendment Number 3 to MOU between IFDC and United States Geological Survey's (USGS) Earth Resources Observation Systems (EROS) Data Center (EDC) to support the World Wildlife Fund (WWF) GIS Strategy for Southern Africa

This document will serve as Amendment 3 to the MOU between IFDC and USGS EROS Data Center. The purpose of Amendment 3 to the MOU between IFDC and the USGS EROS Data Center is to (1) increase the funds obligated under the MOU by $10,000; thereby fully obligating all funds budgeted under the subject MOU and (2) extend the MOU ending date to March 31, 2003.

All the terms and conditions of the MOU by and between IFDC and USGS EROS Data Center dated February 15, 2002, shall remain in full force and effect.

Please return one signed copy of this Amendment to IFDC.

Sincerely yours,

for

Amit H. Roy
President and Chief Executive Officer

ACCEPTED AND AGREED TO:

William E. Fordyce

for Associate Director for Geography 3/26/03

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PROJECT DATA SHEET

PROJECT NAME: Subcontract - USGS with regard to the GISD Pjt.	CONTRACT NUMBER: IFDC Contract #: 01617/02 A3 Donor's #:	COUNTRY: AFRICA
FUNDING AGENCY/CLIENT: Subcontractor: USGS Prime: IFDC/USAID for GISD/WSSD	CONTRACT AMOUNT: $100,000 Initial Obligated Amt:	PAYMENT METHOD: L/C ☐ Check ☒ Direct Deposit ☐ Payable by IFDC
START DATE (month/year): February 15, 2002	COMPLETION DATE (month/year): March 31, 2003	AMENDMENT NUMBER (if any): A3
TECHNICAL REPRESENTATIVE OF FUNDING AGENCY Name: Mr. Larry Tieszen Deputy Manager Address:International Programs EROS Data Center, USGS Sioux Falls, SD 57198 Phone: Fax: Email:	CONTRACT OFFICER/GRANT OFFICER Name: Mr. Thomas P. Clines Email: tclines@usgs.gov Address: U.S. Geological Survey Reston, Virginia 20192 Phone: 703-648-5481 Fax: 703-648-4642	IFDC DIVISION RESPONSIBLE FOR TECHNICAL REPORT MDD ☐ RDD ☒ IFDC/AFRICA ☐

OBJECTIVE:

PROJECT DESCRIPTION:

TECHNICAL DELIVERABLES

Report Type:	Frequency:	Due Dates:	Responsible IFDC Staff:
1.Progress Report	1.Monthly	1.Within 7 days	L. Hammond
2.Progress Report	2.Quarterly	2.Within 20 days	
3.Final Report	3.one	3.Within 45 days	
4.	4.	4.	
5.	5.	5.	

FINANCIAL DELIVERABLES

Report Type:	Frequency:	Due Dates:	Responsible IFDC Staff:
1.Invoices	1.Monthly	1.	D. Shedd
2.Financial Report	2.Monthly	2.Within 20 days	
3.	3.	3.	
4.	4.	4.	
5.	5.	5.	

OTHER DELIVERABLES

Report Type:	Frequency:	Due Dates:	Responsible IFDC Staff:
1.	1.	1.	
2.	2.	2.	

IFDC 01617 02

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Web Site: www.ifdc.org

An International Center for Soil Fertility and Agricultural Development • Un Centro Internacional de Fertilidad del Suelo y Desarrollo Agrícola • Un Centre international pour la Fertilité des Sols et le Développement Agricole

Memorandum of Understanding

Between

International Fertilizer Development Center
PO Box 2040
Muscle Shoals, AL 35662, USA

And

United States Geological Survey's (USGS) Earth Resources Observation Systems (EROS) Data Center (EDC)
Sioux Falls, SD 57198, USA

February 15, 2002

Memorandum of Understanding

Between

International Fertilizer Development Center
PO Box 2040
Muscle Shoals, AL 35662, USA

And

United States Geological Survey's (USGS) Earth Resources Observation Systems (EROS) Data Center (EDC)
Sioux Falls, SD 57198, USA

The International Fertilizer Development Center (hereinafter referred to as IFDC) is a public international organization (PIO) dedicated to increasing sustainable agricultural production through the improved use of yield enhancing technologies. The USGS EROS Data Center has submitted a proposal to USAID to support the World Wildlife Fund (WWF) GIS Strategy for Southern Africa. USGS EDC's activities will focus on the development of a data documentation and discovery system that best meets WWF's needs. EDC, in conjunction with WWF staff and partners, will also explore options for applying available remotely sensed data to environmental monitoring and conservation planning. In order to carryout the work described herein, IFDC and USGS-EDC hereby agree to the following terms and conditions:

1.0 INTRODUCTION AND STATEMENT OF WORK

The United States Agency for International Development (USAID) has entered into an Agreement with IFDC for IFDC to undertake a project entitled "Quick Start for Agriculture in Africa" to support the Geographic Information for Sustainable Development (GISD) project leading up to the World Summit on Sustainable Development (WSSD).

IFDC will provide USAID/EGAD/AFS with logistical and management support to the various partners involved in the implementation of the GISD project, including transferring and providing overall fiscal oversight to specific "pass-through" funds to selected partners who are being asked to implement specific GISD activities. This will include work already identified in

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specific proposals from the NRC, OGC, and several other groups located in the four Target Regions: Upper Niger Basin, African Great Lakes Region, the Kenya-Tanzania Coastal Zone, and the Limpopo/Zambeze River Basin Region of southern Africa.

IFDC will work in close collaboration with the technical officers within USAID providing oversight: Note: The Overall Coordinator is Robert E. Ford, AEMD – Agricultural Enterprise and Market Development Division within USAID's office of Agriculture and Food Security. Robert E. Ford is the Chair of the GISD-IWG for Regional Applications sub-group.

Close coordination must also occur with co-Chairs of the GISD-IWG for each sub-region. They are: Barbara Best (G/ENV) for the Kenya-Tanzania CZM Activity; Paul Bartel and Jon Anderson (AFR-SD) for the Four Corners/Limpopo/Zambezi Basin region; Robert Ford for the Great Lakes/Great Horn of Africa Region; and Mike McGahuey (USAID/AFR-SD).

USGS-EDC, in collaboration with WWF, will guide WWF through the process of documenting their geospatial data holdings using the draft ISO metadata standard and providing access to metadata records via metadata clearinghouse technology. EDC also will explore options for applying available remotely sensed data to environmental monitoring and conservation planning to strengthen existing WWF activities. A description of the activities to be undertaken by USGS-EDC, technical procedures to be followed, deliverables required, and estimated schedule are presented in Attachment 1, which is incorporated as an integral part of this Memorandum of Understanding (MOU).

2.0 SPECIFIC CONDITIONS

2.1 Effective Dates of MOU

The effective dates of this MOU are February 15,2002-September 30, 2002.

2.2 Finance

The work to be performed under this MOU is being financed by USAID with all funds channeled to IFDC. IFDC shall provide funding to USGS-EDC in accordance with the terms and conditions described in this MOU. USGS-EDC may opt to develop a subagreement as necessary to provide metadata training. The estimated funds available to USGS-EDC total US $50,000 (fifty thousand) as follows:

Item	Total US $
Staffing	23,606
Travel Costs	9,127
Other Costs	2,603
Subtotal	35,336
Overhead	14,664
GRAND TOTAL	**50,000**

2.2.1 Use of Funds

IFDC has fiduciary responsibility of funds received from USAID. Under the terms of this MOU, all funds provided to USGS-EDC shall be utilized solely for the purposes indicated in the budget under 2.2. Said funds shall cover all expenditures necessary for the services to be performed by and or arranged by USGS-EDC. IFDC shall not be responsible for any additional costs (i.e., above US $50,000) incurred in the performance of the work described under this MOU.

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2.2.2 Allowable Costs

(a) USGS-EDC shall be reimbursed for costs incurred in carrying out the purposes of this MOU, which are reasonable, allocable, and allowable.

(b) Reasonable shall mean those costs that do not exceed those which would be incurred by an ordinarily prudent person in the conduct of normal business.

(c) Allocable shall mean those costs that are necessary to the MOU.

(d) Allowable shall mean those costs which are reasonable and allocable, and which conform to any limitations set forth in this MOU.

(e) Prior to incurring a questionable or unique cost, USGS-EDC is encouraged to obtain IFDC's written determination as to whether the cost will be allowable.

2.2.3 Payments

IFDC shall make payments to USGS-EDC subject to the receipt of funds from USAID and based upon receipt of an official invoice from USGS-EDC. The invoice may be faxed to the official IFDC Business Contact indicated in 2.6.1. The payments shall be made on a monthly basis in advance based upon USGS-EDC'S submission of financial reports, which substantiate costs incurred in the performance of this MOU and expected expenditures for the subsequent month.

2.2.4 Financial Reports

USGS-EDC shall provide to IFDC a financial report accounting for all allowable costs incurred by USGS-EDC under the program in accordance with the line item budget amounts indicated in 2.2. Copies of documentation to support all costs incurred in performance of work described in this MOU shall be made available to IFDC upon request.

2.2.5 Audit

USGS-EDC shall maintain books, records, documents, and other evidence in accordance with USGS-EDC's usual accounting procedures to sufficiently substantiate charges to this MOU. IFDC and USAID reserve the right to examine and USGS-EDC agrees to make available all financial records and documents of USGS-EDC as related to this MOU. Any costs that are determined by either IFDC or USAID to be inconsistent with the terms and conditions of this MOU shall immediately be refunded to IFDC. By the signing of this MOU, USGS-EDC states that they were informed of, understand, and agree to comply with the applicable compliance requirements.

2.2.6 Refunds

(a) Funds not disbursed to USGS-EDC at the time the MOU expires or is terminated shall revert to IFDC, except for such funds encumbered by USGS-EDC by a legally binding transaction applicable to this MOU. Any funds advanced to but not expended by USGS-EDC at the time of expiration or termination of the MOU shall be refunded to IFDC except for such funds encumbered by USGS-EDC by a legally binding transaction applicable to this MOU.

(b) If, at any time during the life of the MOU, or as a result of final audit, it is determined that funds provided under this MOU have been expended for purposes not in accordance with the terms of this MOU, USGS-EDC shall refund such amount to IFDC.

2.3 Language

The MOU has been executed in English, which shall be the binding and controlling language for interpretation of the terms and conditions of this MOU.

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2.4 Subagreements

It is understood that USGS-EDC may carryout the work described under this MOU in collaboration with others. It is further understood that funds provided to USGS-EDC may be used to support work carried out by collaborating institutions. USGS-EDC shall ensure that the specific conditions of this MOU (i.e., Section 2.0, Specific Conditions) shall apply to all such subagreements.

2.5 Revision of MOU Budget

(a) The approved MOU budget is the financial expression of USGS-EDC's program.

(b) USGS-EDC shall immediately request approval from IFDC when there is reason to believe that within the next 30 calendar days a revision of the approved MOU budget will be necessary for any of the following reasons:

- To change the scope or the objectives of the program and/or revise the funding allocated among objectives by more than ten percent of the total budget amount unless the schedule states otherwise.
- Additional funding is needed.
- USGS-EDC expects the amount of authorized funds to exceed its needs by more than $5,000 or five percent of the MOU budget, whichever is greater.

(c) Except as required by other provisions of this MOU specifically stated to be an exception from this provision, IFDC shall not be obligated to reimburse USGS-EDC for costs incurred in excess of the total amount obligated under the MOU. USGS-EDC shall not be obligated to continue performance under the MOU (including actions under the "Termination Procedures" provision) or otherwise to incur costs in excess of the amount obligated under the MOU, unless and until IFDC has notified USGS-EDC in writing that such obligated amount has been increased and has specified the new MOU total amount.

2.6 Other Terms and Conditions

The following terms and conditions, which are applicable to the MOU by and between USAID and IFDC, shall be integral part of this Agreement.

2.6.1 Official Contacts

The contacts under this MOU for all official contacts are as follows:

IFDC Technical
Dr. Lawrence L. Hammond
Director, Research and Development Division
IFDC
PO Box 2040
Muscle Shoals, AL 35662, USA
Telephone: 256/381-6600, extension 270
FAX: 256/381-7408
lhammond@ifdc.org
www.ifdc.org

IFDC Business
Mr. John H. Allgood
Director, Finance, Administration, and Support Services
IFDC
PO Box 2040
Muscle Shoals, AL 35662, USA
Telephone: 256/381-6600, extension 211
FAX: 256/381-7408
jallgood@ifdc.org
www.ifdc.org

USGS-EDC Technical Business
Mr. Larry L. Tieszen
Deputy Manager
International Programs
EROS Data Center, USGS
Sioux Falls, SD 57198, USA
Telephone: 605/594-5056
Fax: 605/594-6529
tieszen@edcmail.cr.usgs.gov
http://edcintl.cr.usgs.gov ip

2.6.2 Publications and Media Releases

If it is USGS-EDC's intention to identify USAID's contribution to any publication, video or other information/media product resulting from this MOU, USGS-EDC shall state that the views expressed by the author(s) do not necessarily reflect those of USAID. Acknowledgements should identify the sponsoring USAID Office and Bureau or Mission as well as USAID substantially as follows:

"This [publication, video or other information/media project (specific)] was made possible through support provided by the Center for Economic Growth and Agricultural Development, Office of Agriculture and Food Security, under the terms of the MOU. The opinions expressed herein are those of the author(s) and do not necessarily reflect the views of USAID."

USGS-EDC shall provide the relevant strategic objective or results package team with one copy of all published works developed under this MOU and with lists of other written work produced under the MOU.

Except as otherwise provided in the terms and conditions of the MOU, the author or USGS-EDC is free to copyright any books, publications, or other copyrightable materials developed in the course of or under this MOU, but USAID reserves a royalty-free nonexclusive and irrevocable right to reproduce, publish, or otherwise use, and to authorize others to use the work for U.S. Government purposes.

2.6.3 Reports and Data

USGS-EDC shall send to the IFDC Technical Contact at the address included in this MOU, monthly and quarterly progress reports in a form and substance satisfactory to IFDC. The monthly reports will provide a brief report on the status of activities being undertaken to implement this project during the previous 30 days.

The quarterly reports shall indicate progress toward achieving Program objectives and implementing approved work plans. The reports shall include, but not be limited to, the following information:

- Status of achievement of program goals, objectives, and benchmarks specified in the annual work plan
- Progress or completion of components, elements, or activities against planned targets
- Program description
- Other accomplishments or program highlights
- Identification and explanation of significant problems which have been encountered
- Description of planned corrective action

The monthly and quarterly reports may be submitted in electronic format and are to be delivered to IFDC within 7 calendar days and 20 calendar days, respectively, of the end of the reporting period. A final report addressing the same components included in the quarterly report is to be submitted to IFDC by USGS-EDC within 45 calendar days of the ending date of this MOU. The reports submitted to USGS-EDC to IFDC and supporting materials compiled in performing the services shall be the property of USAID.

USGS-EDC is also required to submit copies of reports publications, produced within each activity as requested by the USAID Cognizant Technical Officer (e.g., workshop proceedings, PowerPoint presentations, etc.).

2.6.4 Termination

This agreement may be terminated, in whole or in part, by either party at any time upon 30 days written notice of termination. Upon receipt of and in accordance with a termination notice from the IFDC, the USGS-EDC shall take immediate

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action to cease all expenditures financed by this MOU and to cancel all unliquidated obligations if possible. Further, upon receipt of notice of termination, the USGS-EDC shall not enter into any further obligations under this MOU. Except as provided below, no further reimbursement shall be made after the effective date of termination. The USGS-EDC shall within 30 days of the effective date of termination repay to IFDC all unexpended funds that are not otherwise obligated by a legally binding transaction applicable to this MOU. Should the funds paid by IFDC to the USGS-EDC prior to the effective date of termination be insufficient to cover the USGS-EDC's obligations in a legally binding transaction, the USGS-EDC may submit to IFDC within 90 days after the effective date of termination a written claim for such amount. The IFDC shall determine the amount(s) to be paid by IFDC to the USGS-EDC under such claim in accordance with the "Allowable Costs" provision of this MOU.

2.6.5 Dispute Settlement

Because of the nature of this agreement and the legal status of the respective organizations engaged under this MOU, reconciliation of disputes that cannot be handled amicably will be settled through discussions/negotiations by and between the signatories to the MOU.

2.6.6 Investment Promotions

No funds or other support provided hereunder may be used in a program or activity reasonably likely to involve the relocation or expansion outside of the United States of an enterprise located in the United States if non-US production in such relocation or expansion replaces some or all of the production of, and reduces the number of employees at, said enterprise in the United States.

No funds or other support provided hereunder may be used in a program or activity the purpose of which is the establishment or development in a foreign country of any export processing zone or designated area where the labor,

environmental, tax, tariff, and safety laws of the country would not apply, without the prior written approval of IFDC.

No funds or other support provided hereunder may be used in an activity which contributes to the violation of internationally recognized rights of workers in the recipient country including those in any designated zone or area in that country. This provision must be included in all subagreements.

2.6.7 Non-Liability

IFDC does not assume liability for any third party claims for damages arising out of this MOU.

2.6.8 Notices

Any notice given by either party under this MOU shall be sufficient only if in writing and delivered in person or faxed to the official contact persons identified in 2.5.1

2.6.9 Special Provisions

USGS-EDC shall comply with USAID environmental regulations (22 CFR Section 216 "Regulation 16") with respect to the activities to be undertaken under this MOU.

2.6.10 Procurement Policies and Procedures

Because USAID is the sole contributor, USAID procurement policies and procedures are applicable (22 CFR Section 226 and ADS 308.5.7a).

2.6.11 Ineligible Countries

Activities under this agreement may only be carried out in countries that are eligible to receive assistance under the Foreign Assistance Act. USGS-EDC shall

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provide IFDC in advance a list of those countries where activities are planned under this MOU.

2.6.12 Entire MOU

Unless otherwise specified, this MOU embodies the entire understanding between IFDC and USGS-EDC for the services to be provided and any prior to contemporaneous representations, either oral or written, are hereby superseded. No amendments or changes to this MOU, including, without limitation, changes in the statement of work, total estimated cost, and period of performance, shall be effective unless made in writing and signed by authorized representatives of the parties.

FOR AND ON BEHALF OF IFDC

By: _____

Name: Amit H. Roy

Title: President & CEO

Date: February 19, 2002

FOR AND ON BEHALF OF USGS-EDC

By: _____

Name: Ms. Barbara J. Ryan

Title: Associate Director for Geography

Date: March 6, 2002

WITNESS:

By: _____

Name: Debra E. Rutland

Title: Executive Secretary

Date: Feb 19, 2002

WITNESS:

By: _____

Name: Debra K Polen

Title: Executive Secretary

Date: March 6, 2002

Attachment 1

Technical Support to WWF SARPO GIS Strategy:

Design and training for metadata clearinghouse capability and application of available remotely sensed data to environmental monitoring and conservation planning in Southern Africa

A proposal submitted to Mr. Robert Ford, USAID/Global
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1. Introduction

One of the principal aims of the U.S. Geological Survey/EROS Data Center International program is to assist developing countries in harnessing the potential of geospatial technologies. This is done by empowering local organizations and stakeholders to make effective use of remote sensing and GIS on their own terms and by providing mechanisms to create synergies and networks for improved data compability and access. Specifically, for this project, USGS/EROS Data Center will build capacity in metadata clearinghouse technology and will build awareness in the value of remote sensing for local conservation needs.

Metadata provides a standardized inventory of existing geospatial data. It provides a potential end-user with sufficient information to ascertain whether a geospatial dataset is appropriate for his/her needs. Unfortunately, few institutions using GIS in Southern Africa have begun documenting their data resources. Generally, data have been produced by many different organizations, in an uncoordinated way, and under heterogeneous specifications. Inconsistent data limits the possibilities for integrating and using it properly. Also, there is duplication of effort. Because metadata is lacking, users have difficulty finding out what data are available and evaluating the fitness of the data for their applications.

A Clearinghouse is a distributed service to locate geospatial data based on the standardized characteristics provided in the metadata. A Clearinghouse allows one to pose a query, using dates, key words, place names, and/or geographic coordinates. In this way, a user can quickly determine what data are available. At the same time, a Clearinghouse helps:

- minimize duplication of effort in spatial data collection and processing;
- minimize time and costs associated with finding existing data; and
- provide a means for a data producer to publicize its data collection.
- contribute to transparency of information as custodian institutions are obliged to explicit the conditions of access to their data and adhere to these.

In order for organizations to institutionalize metadata development, they need to appreciate the utility of the data they are documenting. GIS and remote sensing are powerful analytical and predictive tools that can enhance natural resource management and biodiversity conservation. Both technicians and high-level decision-makers will be engaged through demonstrations and discussions.

2. Scope

The USGS/EROS Data Center will work closely with World Wildlife Fund (WWF) and its partners to build capacity in geospatial data documentation and discovery and to use available remotely sensed data as an analytical and predictive tool for environmental monitoring and conservation planning in Southern Africa. The proposed work will be sensitive to the capabilities and philosophy of WWF with a long-term vision for sustainability of remote sensing and GIS related activities. This effort constitutes one of four regional studies being conducted in preparation for presentation to the World Summit on Sustainable Development in South Africa, September 2002 (WSSD Working Group, 2001). The focus of this activity is to support the establishment of a regional network of GIS users within the Southern African conservation community that will improve the adoption of geospatial standards, the exchange of information, and the use of remotely sensed data for conservation planning and decision-making. Results will be prepared jointly with WWF, culminating in both a final report and presentation materials for the World Summit on Sustainable Development in South Africa, September 2002. USGS/EROS Data Center also will contribute to an effort to prepare information policy guidelines for distribution at the World Summit on Sustainable Development. This work is being led by the World Resources Institute (WRI), within the plan of activities for Southern Africa.

3. Specific Results

The USGS/EROS Data Center will work with WWF (and possibly other institutions and projects working in Southern Africa including FEWS NET, Regional Remote Sensing Center, University of Botswana, University of Virginia, EIS-Africa, WRI, Africover, and government representatives dealing with conservation) through workshops and email communication to produce 4 specific results.

Result 1: The USGS/EROS Data Center will work with WWF in selecting and refining the most appropriate system for metadata management and will provide training to set up the system. This activity will increase awareness of available data resources and should encourage communication and cooperation across programs and countries.

Deliverables for Result 1:
a) Review metadata collection tools (e.g. MetaLite, Corpsman, NOAA ArcView extension) so that WWF can make an informed decision about the most suitable option to meet their user needs.

b) Review metadata hosting options (e.g., hosting by WWF, hosting by USGS/EROS Data Center, National Spatial Information Framework (NSIF) Spatial Database Discovery Facility (SDDF), provision of metadata and search mechanism on CD, etc.) so that WWF can select the most suitable approach.

c) Prepare materials for metadata/clearinghouse workshop that will cover data inventory, documentation, searching, and delivery, with an emphasis on use in community conservation in Africa and incentives for metadata development.

BEST AVAILABLE

d) Conduct a metadata/clearinghouse workshop with Southern African partners in order to 'train the trainers' in the draft ISO metadata standard, Z39.50, and Isite software. Either a specialist from USGS/EROS Data Center or a qualified trainer from Southern Africa will do the training.

e) Work with WWF in establishing and registering a Clearinghouse node by SARPO's office in Harare so that cooperators and other conservation specialists will have access to metadata, can perform on-line and off-line queries, and view images of maps (*.jpg). The clearinghouse node in Harare will serve as a model for other SARPO nodes in the future. [This deliverable assumes that WWF will have metadata available to establish a node. WWF staff will be responsible for developing the metadata themselves].

f) Help WWF develop a regional strategy for metadata management.

Result 2: Develop two examples of the value of geo-spatial data analysis for environmental monitoring and management. Initially, scientists from USGS, WWF, and others (e.g., University of Virginia, University of Botswana) will meet in Africa for approximately 10 days to discuss potential projects to be presented at WSSD, September 2002. During this meeting, potential and available data from both USGS, WWF and others will be explained, inventoried, and evaluated. One project could demonstrate how geo-spatial data can be combined with ground surveys to improve monitoring and management at the local level. Another project could be developed for a trans-boundary natural resource management area. The remainder of the time would be spent finalizing the conceptual outline for each selected project and assigning tasks. The work will be completed at each scientist's home office, though still in a collaborative manner.

Deliverables for Result 2:
a) Participate in a workshop with WWF to discuss available remotely sensed data and brainstorm about applications making use of remotely sensed data to meet WWF's conservation aims.

b) Develop an outline for two projects that will demonstrate the utility of remote sensing.

c) Format and exchange data, and conduct analyses for projects agreed upon during workshop.

d) Assist with preparation of presentation materials for the World Summit on Sustainable Development.

Result 3: Establish linkages and synergies between WWF SARPO activities and other programs in the region.

Deliverables for Result 3:
a) Assist with the exploration of potential areas of support and cooperation with respect to software, data, standards, tools, and training from institutions with programs in Southern Africa – e.g. USGS, NASA, NOAA, FGDC, GSDI, ESRI, OGC, USAID, UNEP, FAO, etc.

6. Budget Summary

TOTAL ACTIVITY COSTS

Description	Total
Staffing (Table 1)	$ 23,636
Travel Costs (Table 2)	$ 9,127
Other Costs (Table 3)	$ 2,603
Subtotal	$ 35,336
Overhead (41.5 %)	$ 14,664
GRAND TOTAL	**$ 50,000**

1. Budget assumes WWF covers cost of travel for its participants to attend workshop & meeting

OAB 4-19

MEMORANDUM

April 23, 2003

To: Larry Hammond
Director, Research and Development Division
IFDC
P.O Box 2040
Muscle Shoals, AL 35662

From: Larry L. Tieszen
Deputy Manager, International Program
USGS EROS Data Center
Sioux Falls, SD 57198

Subject: Final Report of Activities, Project in Support of the Geographic Information for Sustainable Development (GISD) Leading to the World Summit on Sustainable Development (WSSD)

This memorandum reports U.S. Geological Survey (USGS) activities under the subject Memorandum of Understanding (MOU) between the International Fertilizer Development Center (IFDC) and the USGS/Earth Resources Observation Systems (EROS) Data Center (EDC). This report was compiled by Gray Tappan, Kate Lance, and Jim Rowland. Progress to date is reported according to three thematic areas of work: (1) Case Studies in the Upper Niger River Basin; (2) Agricultural-Hydrological-Meteorological (AGRHYMET) Advanced Very High Resolution Radiometer (AVHRR)/Normalized Difference Vegetation Index (NDVI) Processing; and (3) Technical Support to World Wildlife Fund (WWF) Southern African Regional Program Office (SARPO) Geographic Information System (GIS) Strategy: Design and training for metadata clearinghouse capability and application of available remotely sensed data to environmental monitoring and conservation planning in Southern Africa.

Theme 1: Case Studies in the Upper Niger River Basin: Sustainable Livelihoods that Balance Natural Resource Conservation and Agricultural Production in the OHVN Zone of Mali and the Yatenga Plateau of Burkina

This section of the report summarizes U.S. Geological Survey / EROS Data Center (EDC) activities that relate to supporting case studies in the Upper Niger River Basin in Mali and Burkina. The case studies were conducted jointly with local and national West African institutions and non-governmental organizations. In both geographic regions,

the case studies examine environmental and agricultural trends over time, and seek to tell a development story about local efforts to manage and conserve natural resources in order to improve agricultural livelihoods while preserving or improving the local natural resource base. The effort also attempted to build awareness and capacity for using remote sensing and GIS as monitoring and mapping tools for improving awareness about natural resource conditions, and the impacts, positive and negative, that humans can have on them.

The activity period began on February 15, 2002 and ended September 30, 2002. However, since preliminary work was underway before February 15, this report provides some of the earlier background and progress made, in addition to the work done during the performance period. This was done to provide a more complete picture of the overall effort.

Introduction to the Case Studies

The international development community and West African host agencies have cooperated to secure sustainable development in the midst of increasing population pressure and limited natural resources. Such efforts have included working with entrepreneurial farmers investing in systems that generate more secure and prosperous livelihoods and decrease natural resource degradation rates. Recent preliminary socioeconomic and biophysical data indicate that farming communities on the northern part of Burkina's Central Plateau (including the Yatenga) and in the OHVN zone (Office de la Haute Vallée du Niger) of southern Mali show much progress toward sustainable production practices and decreasing environmental degradation. Prior to the present study, information available from field surveys, rapid appraisals, and preliminary remote sensing analyses suggested that a significant number of producers are moving from subsistence systems to diversified, revenue-generating systems where yields are increasing and natural resource assets are being maintained. In Mali's OHVN zone, although agricultural production has intensified, there was some evidence that land cover was becoming stabilized as farmers shifted from the traditional practice of agricultural extensification to one of intensification. Farmers were optimistic about the future, and the youth were remaining in their villages to pursue local economic opportunities. On Burkina's Central Plateau, a preliminary report by Ouedraogo et al. (2001), and Reij (2001, personal communication) indicated that thousands of hectares of degraded and unproductive land were being reclaimed using a variety of soil and crop management techniques. These successes shine in contrast to the Sahel region's general problems of land degradation, loss of vegetation cover and diversity, soil erosion, and increasing human pressure on limited natural resources. Indeed, much of the literature on the Sahel over the past several decades speaks of severe land degradation, desertification, soil erosion, loss of biological resources, and a decline in the social and economic well-being of the nations and its people.

A field-based study is nearing completion on the northern part of Burkina's Central Plateau under coordination of CONAGESE (Comité National de Gestion de l'Environnement, part of the Ministry of Environment), and the PNGIM (Programme National de Gestion de l'Information sur le Milieu). The EROS Data Center (EDC) International Program participated in the study as a member of a multidisciplinary team thanks to USAID funding under the GISD (Geographic Data for Sustainable Development) Program[1]. The team's objective was to document land rehabilitation efforts to increase land productivity in farming communities on the degraded Central Plateau of northern Burkina (Yatenga, Bam, Sanmatenga, and Zondoma Provinces). On the northern part of Burkina's Central Plateau, there is field evidence that millions of hectares of land have become severely degraded. At the same time, there is evidence that part of the degraded land has been rehabilitated using a variety of SWC (soil and water conservation) interventions. Thousands of farmers have worked on soil management techniques that have improved the fertility and crop production in their fields. However, until this study, the long-term biophysical trends had not been objectively studied or quantified, nor had the enabling conditions that have led to these improvements. The EDC's role was to contribute to the overall study by providing remotely sensed imagery, technical support in image analysis, helping the team reach definitive conclusions about the biophysical changes occurring at the study sites, and strengthening the technical capacity of conducting remote sensing applications in Burkina by local institutions.

In a parallel study, the EDC, in collaboration with Mali's OHVN, ICRISAT, USAID, and Michigan State University, with support from the present GISD Program and the USAID Africa Bureau, undertook a more modest effort to monitor and quantify trends in natural and agricultural resources at numerous agricultural communities in southern Mali. Results from this analysis demonstrate the positive biophysical impact on natural resources that is occurring in southern Mali, and especially, to their credit, in the OHVN's zone of intervention. The approach uses a combination of field surveys, interviews with farmers, and several remote sensing tools to quantify trends in the past 35 years. The integrated biophysical and socioeconomic approach describes a development story that has resulted in improved economic and environmental conditions for numerous villages.

The following two sections summarize the approach and findings of the Burkina and Mali study areas. We begin by presenting the objectives, background, methods and data used, results and conclusions. The approach is to provide a summary, rather than an in-depth presentation of all the technical details and outcomes of these case studies. We are currently working on publications based on this work that will share more details with a wide international development audience.

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[1] The other members of the multidisciplinary team were funded by the GTZ (German International Development Agency) and the Dutch Embassy.

Case Studies on Agricultural Intensification, Enviromental Trends, and Natural Resource Management on the Central Plateau of Burkina Faso

Overview

The objective of the Burkina study was to study the process of agricultural intensification and environmental trends on the northern part of the Central Plateau, from 1980 to 2002. The study focused on 12 village-based case studies in what is considered the most degraded part of Burkina (see Figure 1). The 12 villages and their surrounding lands (*terroirs*) were selected from preliminary field work which identified them as representative of the many hundreds of villages that have adopted soil and water conservation practices. Three of the 12 villages served as control sites where few or no SWC practices were in use. The study involved a multi-disciplinary team of experts from Burkina, a geographer from the Vrije University in Amsterdam, and a geographer/remote sensing scientist from the EROS Data Center. The approach was to use biophysical (including remote sensing time-series imagery) and socioeconomic tools to establish a baseline for each of the case studies, highlighting the situation at two points in time: 1980, and 2002. Detailed satellite photography from 1968 was also used to gain a historical perspective from that earlier period. The remote sensing component provided by the EDC and the Burkina remote sensing team is presented following this section.

Around 1980 the environmental and economic situation was critical. A series of drought years led to crop failures and hunger. At the same time farmers were cutting trees to expand their fields on land that was marginal for agriculture. This increased erosion and already low grain yields were dropping even further. Between 1975 and 1985 up to 25 percent of the families left the villages and moved to regions with higher rainfall and less pressure on land resources. These people were real environmental refugees.

This desperate situation triggered two responses. Some farmers, who felt themselves with their backs against the wall, started to experiment and to innovate and they did so successfully. A traditional system of planting pits (locally called *zai*) was improved, which lead not only to higher yields, but also to reclamation of severely degraded land (figure 2). A second SWC practice, perfected by farmers was also used. It consisted of low rock walls or bunds, placed along the natural contours of the land (figure 3). Since the early 1980s farmers have brought thousands of hectares of strongly degraded land back into production. The second reaction was from the donor community. They started to fund substantial projects to conserve soil and water and most supported simple and efficient techniques, which were acceptable to local farmers. In the study region more than 100,000 hectares of land has been treated with such techniques, in particular since 1989.

The multidisciplinary teams attempted to assess the impact of the efforts by farmers and donor agencies in the field of soil and water conservation. The preliminary findings are surprisingly positive. Grain yields have not fallen as many predicted, but have increased substantially (50% or more). This has led to greater food security for many households. The following chart summarizes the cereal grain yields from the Bam Province from 1984 to 2001:

Cereal grain yield trends in the Bam Province in kg/ha, from 1984 to 2001 (Source: Direction of Agricultural Statistics, Burkina)

Bam	1984-88	1989-95	1995-2001
Sorgho	446	489	703
Mil	406	478	619

Farmers systematically agree that the yields on fields treated with SWC practices are higher than on untreated fields. The figures above reflect average yields, not merely those on SWC-treated lands. These yield increases are not a reflection of climatic improvement, since the long-term rainfall trend from 1984 to 1999 has been relatively steady (although annual fluctuations can be considerable). Figure 4 presents the average annual rainfall for Burkina, from 1923 to 1999 (Mazzucato and Neimeijer, 2000).

Because families have to spend less money on buying grain on the market, they now have more money to invest in livestock. With higher yields, more crop residues are produced, providing more fodder for livestock.

Water from rainfall no longer flows unimpeded over the land. Instead, its flow is slowed by low stone walls and planting pits, increasing infiltration into the soils. In the early 1980s the groundwater level was falling by an estimated one meter per year. In many of the villages we studied, there has been a spectacular effect on the ground water (especially at Ranawa and Rissiam). In rapid survey conducted in 59 villages in the region, one gets a mixed report: in some villages, no positive effect was noted, but where SWC practices are being used, villagers have noticed a significant increase (rise) of the water table from the time SWC was adopted. In many cases, villagers indicated that they had to dig 10 meters to reach water. After SWC practices were used, they can now find water at a depth of 5 meters.

A striking finding of the remote sensing and field analysis is that land treated SWC techniques have more trees and grasses than in the 1980's. The increased vegetation is due less to tree planting and more to the fact that farmers have started to encourage and nurture natural regeneration. By removing species they don't want and protecting those they like to have on their fields, farmers have integrated trees into their farming

systems. In some cases this has led to a parkland landscape where few trees grew before. Farmers who had virtually no trees on their lands in 1985 now have fields with hundreds of trees. More specific examples will be given under the remote sensing section below.

Another interesting impact observed is the strong reduction in out-migration. In several study villages not a single family has left since soil and water conservation started at a fairly substantial scale. Families and individuals have even begun returning to the village. This is due to a whole range of reasons, including the political and economic crisis in Ivory Coast, growing ethnic tensions in the areas where they settled, family reasons, and the improved production conditions in their native villages.

Not surprisingly the number of poor farm families seems to have decreased substantially in many villages. According to some estimates by villagers using their own criteria the number of poor families diminished by about 50 per cent since 1980.

This story of positive change does not mean that the donor agencies can now divert their attention to other regions and to other activities. Much has been achieved, but even more remains to be done. For this area, land degradation is being reversed, at least partially, and funding and technical assistance from the outside has made a big difference. The experience in Burkina Faso demonstrates that external funding can make a difference and speed up positive change.

Remote Sensing Data, Methods, and Products

The Burkina study on agricultural intensification and environmental trends on the Central Plateau was carried out by four major teams. One of the teams was the remote sensing team, comprised of scientists from the Centre SIGET (a GIS and Remote Sensing Center in Ouagadougou), the EDS (a Burkina natural resource consulting group), and technical support and guidance from the EDC. The remote sensing component of the study was designed to complement, but in no way replace the considerable field work being done by the other project teams at each of the 12 village study areas. The goal was to support the study by using remote sensing to provide unambiguous, photographic evidence of environmental trends, ideally from a baseline period of 1980 to the current situation of 2002.

The EDC participated and helped organize two workshops held at Koubri, Burkina in October 2001 and January 2002, to identify and define a practical approach to using remote sensing in support of the study. Discussions centered around data sources, advantages and disadvantages of data types, image analysis methods, and guidelines to time-series land-cover mapping. Work tasks were assigned to and shared among the remote sensing team members following each workshop.

The imagery was interpreted and used to characterize and map the land cover trends and impacts of SWC practices. Earlier sources of imagery were also sought, but only as a historical reference. The 1980 baseline period was considered key because most of the adoption and diffusion of soil and water conservation practices (SWC) occurred after 1980, first in the Yatenga Province, then in the other provinces. It was also critical to obtain very recent imagery in order to characterize the impacts to date. Another important factor was the need for high-resolution imagery, for all periods, in order to be able to pick up on SWC practices and their impact on the vegetation cover at local scales. We determined that the ground resolution would need to be at least 1 meter for the key study period of 1980 to 2002, and if possible, high resolution imagery would be also be useful for earlier time periods. This requirement precluded the use of Landsat, SPOT, MODIS, Aster, or other medium-resolution sources of satellite imagery. IKONOS images were considered early in the discussions with the Burkina remote sensing team, but were ruled out owing to the high cost. Another criteria in the remote sensing approach was to use methods that could be easily replicated by the Burkina team following the study, and easily replicated in other parts of West Africa. Finally, we sought to involve and engage the Burkina remote sensing team in each phase of the analysis.

The Burkina study relied upon at least three sources of remotely sensed imagery: Corona satellite photography from 1968, aerial photography from the 1982-84 period, and recent color aerial photography acquired by the project remote sensing team in June 2002. Where possible, supplementary aerial photographic coverage was purchased representing the early to mid 1990's. These sources of imagery satisfied our initial requirements: coverage of the key time periods, low cost, replicable in other areas, and one-meter or better resolution (except for the Corona satellite photography with a nominal resolution of two to three meters – still considered high-resolution by most remote sensing scientists).

The aerial photography from the 1980's and 1990's was purchased from the Institut Géographique du Burkina (IGB). Given their experience in mounting their own aerial surveys, early in the project the remote sensing team contracted with them to acquire recent (2001 or 2002) coverage of the 12 study sites. After many months of delays, it became apparent that the IGB would not able to honor the contract and the order was cancelled. This created a dilemma, since recent aerial photography was critical to the project. A fallback plan was put into place: the project would acquire its own aerial photography. EDC scientists had experience collecting aerial photography in Senegal and in Mali, and a similar plan was devised for Burkina. In June 2002, an EDC scientist teamed up with the Centre SIGET (GIS and Remote Sensing Center in Ouagadougou) to fly over the 12 study sites. Four flights were made over a period of a week, with the result that complete, vertically-oriented, stereographic, color aerial photography was acquired of each study site, at a nominal scale of 1:8000. The ground resolution was approximately 25 centimeters. Copies of approximately 1000 photographs were provided to the SIGET Center for analysis and mapping. Figure 5 shows an example of

one of these photos, acquired over the village of Noh. EDC also provided a general technical outline for the preparation and interpretation of the aerial photos with the goal of producing time-series land use and land cover maps of each study site.

Because of the inherent distortion in aerial photography, the EDC provided the SIGET Center with systematically corrected Landsat 7 images of each study area, to be used as a background for geometrically referencing the information mapped from the aerial photographs (as well as the Corona photography, which has its own unique spatial distortion characteristics). The Landsat images were printed at 1:8000 scale in order to facilitate the transfer of interpreted map information from the 2002 color photographs (normally Landsat images are not enlarged to such a large scale, but in this case they were useful as a background image for compilation and registration of the aerial photos; the detailed 2002 aerial photos provided nearly all of the information on land cover and SWC practices). Topographic maps from the IGB at a scale of 1:200,000 were also purchased as a general reference for navigation, for locating places, drainage features, topography, etc.

The EDC produced digital Corona photo-mosaic of the Central Plateau in support of the study, in both hardcopy and digital formats. The mosaic construction was an experiment in geometric rectification. A Landsat ETM+ panchromatic image was used as the reference image in the rectification process. After a few trials, the Corona photo strips were successfully registered to the Landsat image, yielding a seamless digital photo mosaic of the Central Plateau representing the 1968 baseline. The product turned out to be more of a curiosity than a practical tool for the time-series mapping of the study sites. One disadvantage of the mosaic is that some of the detailed information visible on the original film positives was lost in the scanning process. Had we preserved the detail in the digital mosaic, the digital file would have been so immense as to be unmanageable. (A Landsat 7 mosaic was also produced, but it mainly covered the Upper Niger River Basin in Mali).

A derivative of the Corona mosaic was planned if time allowed: the idea was to produce a computer-simulated flight over the Central Plateau using the mosaic, merged with detailed a Digital Elevation Model to be provided by NASA, in time for the World Summit. Unfortunately, the DEM was not delivered in time to showcase this product at the Summit. It, too, would have been more of a technical curiosity than a practical contribution to the study at hand.

Field Data Collection

The members of the remote sensing team became directly acquainted with the physical characteristics of the land-cover and land-use during several field trips taken during 2002. These field trips were instrumental in the photo interpretation and mapping process. Some of the remote sensing team members also participated in the field

studies, including transect surveys to collect detailed physical information on crops and production, SWC practices, vegetation, etc.

The EDC provided both imagery and GPS units to the remote sensing team. The imagery and GPS units will be housed permanently at the SIGET Center for use in future applications.

Time-Series Map Preparation

With the time-series aerial photography and Landsat reference imagery in-hand, the Burkina remote sensing team began the process of preparing time-series land-use/land-cover and vegetation condition maps of each of the 12 study areas. They defined approximately a dozen land-use/land-cover types from the fieldwork. They then constructed photo-mosaics of the 2002 aerial photos, registered to the Landsat base images, at a scale of 1:8000. This was followed by the careful process of manual interpretation of cover types and conditions, including the identification of lands treated with SWC practices. The interpretation process was repeated for the two earlier periods, using the historical aerial photographs and the Corona satellite photographs from 1968. By August 2002, many of the village-based study areas had been mapped, and several example map products were presented by Patrice Sanou, Director of SIGET, at the World Summit on Sustainable Development in Johannesburg. All time-series maps were complete by October 2002. Figure 6 presents the three-period time-series for the Noh study area.

Challenges and Problems Encountered in Time-Series Mapping

In November, the project team, including the EDC project geographer, carefully reviewed the time-series map products. The SIGET map team was commended for the level-of-effort and great detail of the maps. However, the reviewers discovered a serious methodological flaw that compromised the results. Time-series mapping, which is designed by nature to bring out land-use and land-cover changes, must be approached with strict procedural guidelines. All factors must be kept consistent from one date of analysis to another. This includes the spatial detail (i.e. minimum mapping unit size), thematic detail (consistent use of map classes), scale, and geometric properties. Keeping all factors consistent can be challenging, because the sources of imagery are often very different. In our case, the image characteristics of Corona, historical medium-scale/ black-and-white aerial photography, and large-scale color aerial photography did pose challenges to the interpreters. Unfortunately, the interpreters fell into several traps. They produced very spatially-detailed maps from the large-scale 2002 photographs, spatially-general maps from the medium-scale 1980's aerial photographs, and moderately-detailed maps from the Corona photographs. Thus, the first rule of consistency of spatial detail had been broken. This was further complicated by the fact that they used too many thematic land-cover classes, many of which could not be consistently identified from one image date to another. They ran

into other difficulties, but the main problems were those mentioned above. They then used a GIS to derive comparative statistics of land-use and land-cover change, based on the maps. They concluded that great land-cover changes were occurring (predominantly negative trends) in all study sites, whereas in reality, many of the changes resulted from inconsistencies in the mapping. Despite the considerable level-of-effort put into generating the maps and statistics, the project team was obliged to reject the results of this first effort. The remote sensing team regrouped, reviewed the methodological problems, and initiated a second effort to produce usable maps and statistics still needed by the project. Owing to time limitations, less ambitious goals were defined by the project steering committee, including a more geographically focused analysis on transects that bisect each study area. Full-coverage time-series maps were required for 3 of the 12 study areas. As of this writing, this effort had just been completed by the Burkina remote sensing team, and the report is currently under review. Although there are still some map corrections to be made, the basic time-series analysis is sound.

We felt that it would be premature to include examples of the maps in this report, as they will require some revision. However, we include the following written analysis of three of the 12 case studies as examples of some of the useful and quantitative information gleaned from the time-series imagery.

Time-Series Image Analysis of the Ranawa *Terroir*

Ranawa is one of the most remarkable villages of the entire study. It provides us with a graphic example of what can be done to improve environmental conditions in a harsh, resource-poor, Sahelian landscape. The evidence is clear, whether you are driving through the village terroir for the first time, or viewing the resources through time-series imagery. The following is a discussion of the trends as determined through the time-series imagery.

In 1968, the overall picture of the Ranawa terroir is one of an agricultural tree parkland occupying a broad valley, surrounded by low lateritic plateaus covered by an open bushland. Unlike many of the other study villages, the tree parkland is quite well developed, and there are relatively few areas where the parkland thins out. One of the relatively treeless areas is comprised of agricultural fields at the eastern end of the terroir, bounded by the slopes of the plateau.

Comparing the 1968 land cover to the situation depicted in the 1984 aerial photograph, we see confirmation that the agricultural tree parkland remains intact, with little evidence of decline (despite severe drought in 1970-1974 and 1982-1984). However, the 'natural' vegetation on the surrounding plateaus has degraded, no doubt the combined effects of drought and increasing human pressure on woody resources, especially firewood collection.

By 1984, Ranawa was one of the few villages that began experimenting with SWC in the form of rock lines along the contour. Indeed, one can see the beginnings of the rock lines in the 1984 aerial photo on the fields at the eastern end of the terroir. The lines had already been in place for at least several years, as evidenced by the regeneration of woody vegetation along many of the lines.

Turning to the 2002 aerial photographs, we find that Ranawa is still dominated by impressive agricultural tree parkland. Quantitative measurements taken along an east-west transect through the terroir indicate that the tree cover in the agricultural parkland amounted to 7 percent in 1984, and had increased to 12 percent in 2002. Rarely do we see agricultural tree parklands of this density in Sahelian West Africa. The diversity of trees is also quite high, as seen by the various tree canopy types that can be recognized on the 2002 color aerial photographs. Clearly, protecting and nurturing the development of the tree parkland is a priority for local farmers, and their efforts are paying off.

A relatively minor fraction of the cultivated lands of Ranawa occur outside the parkland, particularly in the western areas. These fields also appear not to have been treated with rock lines. For these untreated fields, the vegetation cover is low and the trend is stable: 3 to 7 percent in both 1984 and 2002. In contrast, the densest areas of tree cover occur along several low drainage channels. In 1984, the tree cover averaged 22 percent, but this figure increased quite substantially to an average of 33 percent in 2002. These areas are part of the agricultural tree parkland, subject to seasonal flooding.

Perhaps the most impressive environmental changes in Ranawa occur on the agricultural fields at the east side. These areas were nearly barren in 1968, were being rehabilitated using rock lines by 1984, and have today become important croplands. This is a classic example of the rehabilitation of the degraded *zipéllé*. In 1968, the woody cover was nearly zero; in 1984, vegetation regeneration was already occurring along the rock lines, with total woody cover of 5 percent. In 2002, the woody cover had reached 11 percent, nearly the level of the mature tree parkland. This local example is one of the most impressive positive physical changes we have encountered among all 12 study sites. It should serve as an example of the great possibilities for environmental improvement in this harsh region.

What makes the above example all the more remarkable is the fact that the main Ranawa village cluster lies less than 100 meters from the rehabilitated land, and the fact that the village has grown quickly in size over the past 3 decades. Although actual population figures are always difficult to obtain for individual villages, the area of a village can serve as a proxy for population growth. Village area is rather easily measured from the time-series photographs. In the case of Ranawa, in 1968 village area totaled 0.6 hectares. By 1984 it had grown to 2.5 hectares, and in 2002 it

occupied 3.1 hectares. Thus, the village area grew by over a factor of 5 over the 34-year period.

Time-Series Image Analysis of the Sam *Terroir*

The village of Sam presented us with one of the pleasant surprises of the entire study. We knew that the villagers were using a modest level of SWC practices, but it was not until we completed the time-series aerial photo study that we realized the great impact of the use of these practices on increasing the vegetation cover and decreasing soil erosion. The main areas of intervention are on cropland to the southwest of the main village clusters. In 1968, the Corona photo clearly shows a large area of degraded, nearly treeless cropland to the south and west of the intermittent drainage channel that crosses through the *terroir*. Extending beyond the cropland is a large, denuded *zipéllé*, and areas of open bushland. Most of the farmed areas of Sam appear nearly treeless, and even the drainage channel was fringed with relatively few trees. There is evidence of a bush fallow system in use, as some areas within the *terroir* appear uncultivated, with evidence of short-term bush encroachment.

Fourteen years later, in 1982, the cropland areas are for the most part bare, with only a few scattered trees in the fields. The bush fallow system is still in use, showing in a shift in the cultivation – fallow pattern relative to the earlier photo. Bush cover is seen to regenerate in the fallow areas. There is no direct photographic evidence of the use of SWC practices in the fields. Surprisingly, there is a significant increase in riparian trees along the drainage channel (relative to 1968), with trees cover covering about 30% of the low-lying area.

Between 1982 and 2002, a remarkable transformation began to occur in the cropland areas. The 2002 photos show numerous rock bunds, some on the contour, others placed at odd angles. What is most striking is the regeneration of trees and bushes along the contours, and the increase in field trees on the treated land. Using the aerial photos, we quantified the percent woody cover on cropland treated with SWC in 2002, and compared these results to the same areas on the 1982 photo. In 2002, woody cover on treated land had reached a respectable 10%, up from 5% in 1982. Because most of the tree cover is composed of young, small trees, we expect the percent cover to increase significantly in the next decade. The impact of the SWC practices on cropland is only just beginning in Sam, but the results are already very impressive.

Doundougou

The land cover trends in the Doundougou *terroir* over the past 35 years exhibit an overall decline in the vegetation cover. The positive impacts seen in physically similar *terroirs* such as Sam have not yet been realized in Doundougou. On a positive note, however, there is clear evidence of the recent introduction of SWC practices in the form

of rock lines on fields to the south of the main drainage channel. Judging from what we have seen in other terroirs, we fully expect these interventions to lead to positive gains in vegetation cover, a reduction in soil erosion, and increased water infiltration.

In 1968, the Corona satellite photograph shows that the terroir is surrounded by relatively dense bushland formation. Cropland is limited in area, supporting a small population, with individual fields carved out of the bushland. There are relatively few field trees, and some fields appear quite denuded. The gentle slopes along the drainage channel show signs of severe erosion, forming small *zipéllé*.

By 1983, as seen in the aerial photographs, there was a significant decline in the vegetation resources, both on farm and in the surrounding bush. As with other sites, drought seems to have taken a toll. Part of the vegetation removal is a result of expansion of cropland area into the bushland. Between 1983 and 2002, the vegetation cover stabilized somewhat, but never regained the level of cover seen in the 1968 Corona photo. We quantified the vegetation cover trends along a representative transect, using the 1983 and 2002 aerial photographs. Untreated cropland in both periods exhibits very sparse vegetation cover: 1.6 percent in 1983 and 1.5 percent in 2002. Fields that were treated with rock lines in recent years occur in fields with somewhat more vegetation cover: 6 percent in 1983 and 6 percent in 2002. It seems that the SWC practices are too recent to have had an impact on the vegetation. The surrounding bushland has declined in cover from 27 percent in 1983 to 18 percent in 2002. Percent cover was significantly higher in 1968, but resolution limitations associated with the Corona photograph preclude making quantitative measurements of bushland formations. Finally, the riparian tree cover associated with the main east-west drainage channel has quite stable over the last 20 years: 20 percent cover in 1983; 19 percent cover in 2002.

Differences Between Sites Using SWC and 'Control' Sites Without SWC Practices

Among the 12 case studies, 3 village sites were chosen as control sites to determine if sites without SWC interventions were significantly different from those with SWC-treated lands. After carrying out some of the fieldwork, it became clear that these villages actually had used some SWC practices, and that they would not represent true control sites. Conversely, some of the 9 villages considered to be significant 'users' of SWC were in fact just getting started (e.g. Doundougou); most presented a complex picture in that some fields were treated with SWC while others were not. The concept of testing for significant differences between these 3 three villages and the other 9 was not pursued since, in reality, all used some degree of SWC, and the levels of use could not be generalized at the village level. Rather, the impacts of SWC practices were evaluated at the field and household level. The image analysis clearly shows the contrast between treated and untreated fields, especially where SWC has been in place for a number of years. Impacts of SWC on household revenues, yields, diversification

of income-generating activities, migration, and other factors will be discussed in reports prepared by the other project teams.

Conclusion and Next Steps

The results of the time-series image analysis are just part of the overall effort by the four teams to study the process of agricultural intensification and environmental trends on the Central Plateau. Despite a setback in the initial image analysis, the remote sensing component has made a very significant contribution to the study, providing clear graphic evidence of agricultural intensification and land management practices that are leading to increased yields, improved economic conditions, reduced poverty, and a halt to out-migration. There is no question that SWC practices are having a positive effect on yields, reclamation of barren surfaces, and regeneration of on-farm vegetation. The imagery and derived map products are already helping us share this important development story with the development community and the general public.

The process of generating time-series land-cover maps from several image sources was a new experience for the Burkina remote sensing scientists. The challenges and problems encountered along the way provided an excellent learning opportunity. The overall exercise strengthened their capacity to carry out future environmental trend analyses. They saw first-hand the pitfalls of time-series mapping, and were able to correct their approach.

Early results of both the imagery and maps were prepared in time for the World Summit on Sustainable Development in August 2002. Socioeconomic results were also presented, tracing the transformation process from a harsh environment and difficult economic situation of the 1980's, to an improved, diversified agricultural situation of today.

As a result of presentations at the World Summit, the international media began to follow this developing story with keen interest. After the Summit, numerous interviews were given with major European radio stations, including the BBC, Radio France Internationale, and Deutche Welle. A British television documentary producer traveled to Burkina to interview the project team. Articles were run in many major European newspapers. The American press also began to run articles, notably the Boston Globe (December 2002), Discover Magazine (January 2003), and National Geographic Magazine (in press). Within Burkina, interest in the results is growing among the country's leaders, including several cabinet-level officials. The project team organized field trips to the Yatenga and Bam Provinces for both the former and current U.S. ambassadors to Burkina, as well as the German ambassador and the head of the Dutch development agency. The team also briefed several provincial governors.

Funding from the German and Dutch donors will continue through June 2003. During the final months, the remote sensing team will finalize the time-series maps and analyses. Reports from the other teams will be completed, and an overall synthesis

report prepared. A final workshop has been scheduled by the project team for late June, in Ouagadougou, to present the results to high-level government officials, international donors, and development NGO's. An additional workshop is planned to be held in one of the provinces to provide feedback to village representatives from all 12 study areas. These workshops represent the official end to this activity. However, efforts will continue thereafter to publish the results.

Case Studies on Monitoring Environmental Dynamics and Agricultural Intensification in Southern Mali (1965 – 2002)

Introduction

A team comprised of scientists and field technicians from the EROS Data Center (EDC) and the OHVN (Office de la Haute Vallée du Fleuve Niger) in Mali defined an approach to monitor land resource trends in one of OHVN's major zones of intervention. The objective was to track indicators of agricultural intensification in rural communities in the OHVN zone, from 1965 to 2002. A second objective was to evaluate the use of remote sensing tools for long-term monitoring of natural resources and agricultural trends at local scales, and to introduce these tools to OHVN staff. The study goals are similar to those of the Burkina project described above, although more limited to an assessment of land use and land cover trends. The OHVN staff began by identifying nine village-based study areas, based on evidence of significant adoption of a variety of natural resource management practices. To these nine, we added an additional 12 village-based study areas to compare land-use and land-cover trends between those that had received OHVN technical assistance in natural resource management, and those that had received little or no training in NRM. The cluster of 21 study areas is located in the Arrondissements of Sarankoroba and Ouelessebougou, south of Bamako. Figure 7 shows the general location of the OHVN study area in Mali.

Preliminary fieldwork and reconnaissance aerial surveys were initiated over the study area in November 2000. The present effort built upon experience and preliminary data sets collected at that time. It also builds upon reports from field trips conducted by McGahuey (1998) and Kelly (2000) carried out in 1998 and 1999.

The early field reports by McGahuey (1998) and Kelly (2000), and the reconnaissance aerial survey conducted by EDC showed that farming communities within the OHVN Zone of southern Mali exhibit positive trends in the adoption of natural resource management, agricultural production through increasing yields, and increasing stability in the use of land for cultivation (little or no expansion into 'natural' habitats), despite the pressures of increasing population and periods of drought. Our hypothesis is that these positive trends stand in contrast to conditions in surrounding communities that have not benefited as much from outside intervention (extension work, training, etc.). The thought is that village lands that do not show evidence of continuing agricultural

expansion are intensifying and diversifying production (including non-agricultural economic activities).

The study focuses on one of OHVN's main zones of intervention: the Ouelessebougou and Sarankoroba sectors south of Bamako. This is a small but important rural *production zone. According to OHVN statistics, the area includes over 200,000* hectares of cultivated land in 1999, including over 5 percent of Mali's cotton production, 2.3 percent of coarse grain production, and 3.5 percent or rice production. This zone is on the southwestern fringe of Mali's major cotton region. Because it is not it the core cotton region where agricultural saturation has occurred, much of the land is still covered by various forms of natural vegetation, providing important forest products to surrounding cities, including Bamako. Despite this, the region is plagued with serious problems of soil erosion, deforestation, and loss of unique wetland and gallery forests. For this reason, a more concerted effort is needed to monitor and characterize the changes, positive and negative, occurring in the region. An outcome of the present effort is to increase awareness of the land resource changes among OHVN staff, and among their development partners in Mali.

The USAID bilateral mission in Mali began to support the OHVN in 1973. Key components of this support, particularly since 1990, have included the restructuring of the OHVN to improve the quality of its extension services. Another thrust was to move credit and market activities to the private sector. Another important area of USAID support was the priority given to promoting natural resource management (NRM) techniques (Kelly, 2000). In other areas of West Africa, the adoption of NRM practicess has been shown to be a catalyst for improving agricultural production, rural livelihoods, and improving the resource base. The current monitoring effort contributes to USAID's interest in monitoring the impact of NRM use in the OHVN, particularly in regard to the process of agricultural intensification and conservation of off-farm vegetation resources.

The approach was to use remote sensing and geographic information systems to collect and analyze time-series data to derive trends in cropland are and natural resource conditions (especially vegetation cover). Satellite imagery from 1965 through 2001 were collected, analyzed, and used to produce maps and statistics on land use and land cover trends.

Description of the Study Area

The study area focuses on the village lands or *terroirs* of 21 agricultural communities within the *Arrondissements* of Sanankoroba and Ouélésébougou, in the southern part of the *Cercle de Bamako*. The communities lie within a 45 X 45 km area, centered on a point about 60 km south of Bamako. This places the study area within the Haut Bani-Niger *Occidental, an agroecological region that lies in the central Sudanian bioclimatic* region of West Africa. Average annual rainfall ranged between 1000 and 1200 mm in the 1940's through 1960's, but declined to 800 to 1000 mm during the 1970's, 1980's.

and 1990's. The rainy season extends from May to October, but the rains are concentrated in a period of 70 to 80 days. The annual mean temperature is approximately 30 degrees C. According to Fofana et al. (199?), this agroecological region includes 29% non-arable lands, and 71% arable lands comprised of loams and loamy-clays. The geomorphology is that of a plain with low hills, gentle slopes and broad valleys. Laterite caps many of the low hills, forming a nearly impenetrable surface devoid of most woody vegetation (called *bowé* in Fulani). Geologically, the area lies on the Precambrian Shield, composed of undifferentiated granites. The natural vegetation reflects the diversity of landscapes. One can find a wide range of vegetation formations, from the nearly bare *bowé* surfaces to the gallery forests along watercourses. The predominant formation in less disturbed areas is the wooded savanna. More disturbed sites are dominated by open shrub and tree savannas. Agricultural tree parklands dominate the cultivated fields in the broad valleys.

This region is known to have serious erosion, soil degradation and deforestation problems. Expansion of cropland into natural areas was common, particularly driven by the economic pressure to produce more cotton. Human pressure on woody resources was also acute, from both local and external sources. Despite this, anectodal evidence from preliminary field surveys indicated positive trends over the last decade. Farmers interviewed related that life is better now than 10 years ago. They indicated that yields of all crops had increased, especially among farmers adopting SWC practices. There was less out-migration in recent years (McGahuey, 1998).

Cultural Geography and Agriculture

The population is primarily composed of people from the Bambara ethnic group. Most are smallholder farmers. The 1976 census indicated a rural population density of 14 to 21 people per square km. Today, dozens of small agricultural communities inhabit the broad valleys between the low-lying hills and crests. From an aerial perspective, it is evident that most cultivated fields occur on the best sites and on the better, deeper soils of the broad valleys and shallow slopes; cropland is generally absent from the uplands and ironpan surfaces. The pattern of natural and cultural landscapes is mainly a reflection of the type of soil, the spatial pattern of fields, the cropland use intensity, the field type, and the agricultural practices.

The primary crop types can be distinguished by the means of water supply. Crops in hydromorphic zones along valley bottoms and depressions are seasonally subject to flooding. These areas are primarily devoted to rice. The broad valleys and gentle slopes are devoted to rain-fed crops, the predominant agriculture in this part of Mali. The main food staple crops are millet and sorghum, and to a lesser extent, maize. These crops are cultivated throughout the study area. Cotton is the most important cash crop and main source of outside revenue. Cultivation of peanuts represents a secondary cash crop. Farmers maintain useful trees in these fields, primarily the *karité* (*Vitellaria paradoxa*), followed in rank by the *néré* (*Parkia biglobosa*). The fruit of the

karité is the shea butter nut, which is harvested and processed by women. This is a major income-generating activity.

Land tenure in Mali can be characterized by the coexistence of the customary land laws and the national codes on land tenure. Under customary law, access to land is traced back to the 'right of the axe' and 'right of fire', and by inheritance (Maiga, 1994). Over 90 percent of the cultivated lands in Mali are managed under the customary land laws. The village is truly the focus point for decisions regarding land ownership and use. The national land tenure code in Mali recognizes the customary land laws as long as the State does not need the land for its purposes.

Raising livestock is another important activity. This sector has seen a significant increase in recent years. Besides the traditional livestock owners (agropastoralists), others including farmers, merchants and civil servants have been investing in livestock. Animal herds represent a means of investing and accruing capital. Furthermore, owning livestock is complementary to growing crops. It provides animal traction for use in the fields, a source of manure, and a variety of animal products.

Remote Sensing Data

Our intent was to use a variety of practical, low-cost tools to evaluate the trends in land use / land cover, and natural resource management techniques at the local scale of the *terroir villageois* (traditional village managed lands). This approach included multiple remote sensing systems, brief field visits, and semi-structured interviews. Remotely sensed images acquired over time were used to generate time-series maps. Changes in land use / land cover were described and, where possible, quantified. A second objective was to demonstrate the use of these monitoring and mapping tools to our counterparts in the OHVN agency.

This study relied heavily on historical and current records of the land surface resources in photographic and image formats. In compiling the data sets, we sought imagery that (a) provided a record for period of at least three decades, (b) was readily available, both over this study area and across broader areas of West Africa, (c) was relatively inexpensive to acquire and process, and (d) provided medium to high resolution coverage needed to make local scale assessments. We assembled remote sensing data from six different sources, representing four distinct types (Table 1). In addition to these data, we also obtained two base maps covering the study area at 1:200,000 scale, from the Institut Géographique du Mali.

Table 1. Remote Sensing Data Assembled for the OHVN Study Area

Date	Sensor	Format	Scale at Interpretation	Source
April 1943?	Aerial Camera	9" X 9" B&W prints	Variable (oblique photo)	U.S. Army Air Force
10 Dec 1965	Satellite-based camera	5.5 X 74.5 cm B&W film positives	1:330,000, enlarged to 1:41,250 (print)	USGS EROS Data Center
6 Mar 1978	Aerial Camera	23 X 23 cm B&W prints	1:50,000	Institut Géographique du Mali (Mission KLM Mali-Sud)
26 Oct. 1988	Landsat TM	Digital image on CD	1:50,000	USGS EROS Data Center
25 Oct. 1999 and Oct. 2001	Landsat ETM+	Digital image on CD	1:50,000	USGS EROS Data Center
Nov. 2000 and Nov 2001	SLR Camera	35 mm color slides	Variable, large scale, vertical and oblique aerial photos	USGS EROS Data Center

1943 Aerial Photography: This photography was taken by the U.S. Army Air Force, covering much of West Africa. It was flown using B-17's and B-24's. The photos were used to prepare aeronautical charts during World War II. Unfortunately, the coverage of the study area is limited to the southern edge, and the photos exist only in oblique format. The quality and detail is very good, and land use / land cover assessments are feasible using the foreground portions of each photo.

1965 Corona Satellite Photography: Four Corona frames provide complete coverage of the study area. These are part of a world-wide archive from the 1960's. There is 100% coverage of Mali. The ground resolution of film positives is on the order of 2 meters. The Corona Program was part of the U.S. space-based reconnaissance system during the Cold War era. These historical satellite photographs were declassified in 1995 in the interest of science. They provide a remarkable record of the Earth's surface some 35 years ago.

1978 Aerial Photography: This general purpose aerial photography was collected to update the coverage of southern Mali. Unfortunately, the reproduction quality of the prints we purchased was very poor. Vignetting effects were exacerbated in the reproduction, leading to areas of over- and under-exposure. The photos were used as a general reference, but were not directly used in this study. **can we measure village size?**

1986/1988 and 1999/2001 Landsat Images: The 1986/1988 Landsat TM images were selected because they represents the period when USAID and OHVN were just beginning to intervene in the study area, providing a good pre-intervention baseline. The 1999/2001 images represent the near-current land use / land cover situation. All

images were acquired in late October at the start of the dry season. The various land cover types are more readily distinguished at this time of year.

2000 and 2001 Aerial Surveys: The most recent aerial photographs were collected by the EROS Data Center, using a rented airplane (Cessna 150). Quasi-vertical to oblique color photographs were taken from a low altitude of about 1200 feet above ground level. The aerial survey was not intended to provide complete coverage. Rather, it provided a detailed set of photographs to help define land cover classes, and to aid in interpretation of the Landsat images (unlike Burkina, we used time-series Corona and Landsat as the primary source of imagery for the study). Figure 8 shows two typical photographs taken over the study area.

Field Data Collection

We traveled to the study area in November 2000 and February 2001 with the following objectives: (a) become acquainted with the physical geography of the area, (b) define land use and land cover types that could be mapped and monitored over time, (c) gain a perspective on the cultural patterns including human use and modification of the natural ecosystem, agriculture, and natural resource management practices. We documented a variety of landscapes, using a GPS and camera to record our observations. We also spent many hours conducting semi-structured interviews with farmers in order to gain an insight into the changes in natural resources and agricultural practices that had occurred in their lifetimes. Our visits to this OHVN sector are a follow-up to visits made earlier by USAID and OHVN agricultural and economic specialists (see McGahuey, 1998; Kelly, 2000). The earlier visits served to collect a wealth of anecdotal and statistical information on natural resource management trends in these and other *terroirs* in the OHVN Zone.

Definition of Land-Use and land-Cover Classes

Field observations and the aerial survey served to identify distinct land-use and land-cover classes that could be readily mapped and monitored through time. Six classes were identified:

Cropland: All agricultural fields were mapped. No distinction was made between irrigated and rain-fed agriculture; the latter type is predominant. Short-term grassy fallow fields were included in this class. Many fields include field trees, particularly the *karite* and the *nere*.

Tree Savannas and Savanna Woodlands: This class includes non-agricultural vegetation formations, all with a woody cover component. The formations range from relatively open shrub and tree savannas, to moderately open savanna woodlands. The percent woody cover ranges from about 5 to 40 percent. The formations can be both relatively pristine to heavily degraded, a result of woodcutting and annual grass fires.

Gallery Forest and Woodland: The gallery forest is a dense, semi-evergreen woodland formation found along watercourses; the woodland refers to an open dry woodland typical of the Sudanian bioclimatic zone. The tree cover ranges from 40 to 80 percent cover.

Bowé Grasslands: These are grasslands mostly devoid of woody vegetation, occurring on the laterite surfaces that cap many of the plateaus of the region. They are unsuitable for agriculture, but do provide grazing land during the wet season.

Eroded and Highly Degraded Soils: These areas are characterized by bright, bare surfaces that have lost most or all capacity to support vegetation. The topsoil layers may have eroded away.

Water Bodies: This unit includes semi-permanent ponds and lakes.

Mapping Approach

The following is a brief summary of the steps taken to produce time-series land-use and land-cover maps and statistics for each of the 21 village-based study sites.

The first task was to prepare the photographic and image data for interpretation and comparison. An initial consideration was to adopt a mapping scale consistent with both the resolution limitations of the imagery, and the dimensions of the features under study. The village territory, or *terroir villageois,* is a small geographic unit. In the OHVN zone, a typical *terroir* may cover no more than 9 square kilometers. Experience working with 30-meter resolution Landsat TM imagery in Africa has shown that it can be used for mapping at scales as large as 1:100,000. However, Landsat 7, the latest satellite in the Landsat series with its Enhanced Thematic Mapper Plus sensor, is endowed with a two-fold improvement in resolution if the panchromatic band is used (30 meter multispectral and 15 meter panchromatic). For the OHVN Zone, we enlarged both the multispectral and panchromatic band images to 1:50,000. Most analysis was done directly from the computer screen, rather than on hardcopy prints. We used multispectral bands 5, 4, and 3 to create the color composites, which portrays vegetation in various hues of green. Hardcopy prints were nonetheless produced for sharing and distribution among OHVN colleagues.

Topographic maps are generally available for Mali at 1:200,000 scale from the Institut Geographique du Mali. The Bamako-Est and Bougouni sheets cover the study area. The scale is rather small for *terroir*-level studies, so these were used for general orientation, for locating the villages, and for planning the flight lines, but they were not suitable as a base for mapping

The Corona satellite images were also prepared for the mapping process. They are archived at EROS in the form of film negatives. The appropriate Corona frames from the December 10, 1965 acquisition were purchased. The transparencies were then digitally scanned, yielding digital images that could be manipulated using image processing software. The nominal resolution of the original photographs was 2 to 3 meters. Some loss of detail occurred during the scanning process.

Five Corona photographic frames were used to generate a general-purpose digital mosaic of this portion of the Upper Niger River Basin, including the OHVN zone. The digital mosaic was rectified using the 1999 Landsat ETM panchromatic (15-meter) band as a reference image. The mosaic was successfully constructed and provided to the OHVN staff as a historical reference of the region (representing the 1965 situation). Besides the Corona mosaic, a 15-image Landsat ETM digital mosaic was constructed over the Upper Niger River Basin of Mali. It was also used as a general-purpose reference image for future studies in the region.

Mapping, quantifying, and monitoring land resources on a *terroir* basis requires that boundaries be established for each *terroir*. However, the thousands of *terroirs* that occur in Mali have never been mapped, and their boundaries can only be ascertained through extensive groundwork. During in-depth village-based studies, *terroir* boundaries are often depicted on sketch maps, and later transferred to base maps. However, this was not feasible for studies that encompass numerous *terroirs*. Our approach was to approximate the *terroir* area and its boundaries by delineating rectilinear polygons around each village, bisecting the distance between villages and placing boundaries at the midpoints. For some of the study sites, a simple box was drawn around the central village. While these are only approximations of the complex reality on the ground, the resulting polygons allow us to quantify trends for the same geographic locations in a consistent manner.

The digital Landsat images from 1986/1988 and 1999/2001 were manually interpreted to generate land use and land-cover trend statistics each of the 21 village study sites. The interpretation was greatly facilitated by validating it against the recent color aerial photographs, which covered many of the study sites. The 1999/2001 images were interpreted first, since they were acquired within the same general timeframe as the aerial surveys. The 1965 Corona photograph was interpreted last. Although the land use patterns change as one travels back in time, the detailed nature of these photographs made interpretation relatively straightforward.

The initial intent was to produce time-series maps of each of the 21 study sites. Several sites were mapped, including Sanambele, Sougoula, and Dakoro. However, it became clear that actual maps were not needed in order to obtain reliable land-use and land-cover trend statistics, and thus the labor-intensive mapping process was bypassed. Instead, the three-period time-series images of each site were enhanced, and the area of land-use and land-cover was interpreted and measured directly from

the images, for each period in time. The maps of the three study sites were nevertheless useful to demonstrate the process of time-series mapping to our counterparts. Strict guidelines for time-series mapping were observed, as discussed earlier in the Burkina project. Figure 9 shows the time-series maps of the Sanambele study site.

Land-Use and Land-Cover Trends

The percent area of each land-use and land-cover type was quantified for the 21 village-based study sites, for each of the three periods. The graphs in figure 10 show the results of six representative land-use and land-cover trends. The trends fall into three distinct groups: (a) village *terroirs* where agricultural expansion (extensification) continues to the present day; (b) village *terroirs* where agricultural expansion has leveled off since 1986/1988, indicating a trend toward intensification/diversification; and (c) village *terroirs* where agricultural land has contracted since 1986/1988, showing a strong trend toward intensification/diversification. Nine of the 21 villages are ones that have directly benefited from OHVN interventions for at least 10 years. The others have had little or no contact with the OHVN. Of the nine OHVN villages, seven of them (77 percent) fall into the groups that show trends of agricultural intensification (Kafara, Sougoula, Tamala, Bini, Digan, Sanambele, and Dialakoro). Farani and Kombo are the only two OHVN intervention villages where agricultural expansion continues to encroach upon the natural vegetation. The villages of Kita, Sanankoro-Djitoumou, Nianzana, and Kolimba show evidence of intensification (and thus protection of the natural, wooded vegetation types), although the OHVN has not pushed NRM practices in these villages.

The following table groups the study villages according to the land-use and land-cover trend patterns. The first group results from a continued pattern of agricultural expansion (extensification) at the expense of the surrounding 'natural' vegetation. The second group (center) presents terroirs in which agricultural land area has stabilized since the 1986/1988 period. The third group (right) lists the terroirs that show a decrease in agricultural land since the 1986/1988 period. Villages that have had a 10-year or more history of OHVN interventions are shown in bold.

Cropland Expands	**Cropland Stabilizes**	**Cropland Decreases**
Dinfara	Kita	**Bini**
Kombo	Sanankoro-Djitoumou	Kolimba
Digamba	Nianzana	**Digan**
Diena	**Kafara**	**Sanambele**
Dara	**Sougoula**	**Dialakoro**
Kaban	**Tamala**	
Falan		
Zambougou		
Daman		
Farani		

The land-cover and land-use trends of these groups of villages are quite distinct from each other, particularly the first group (agricultural expansion) from the other two. From the land-cover perspective, the OHVN seems to have made a distinct difference in influencing the process of intensification. This will need to be confirmed by ground studies to determine the level, type and duration of OHVN intervention.

A related positive indicator is the condition of the unfarmed, wooded land areas among the OHVN villages. The analysis of high-resolution satellite photography, and aerial photos taken by EROS Data Center staff in 2000 and 2001, show that for many areas, there is evidence of decreased forest degradation. At Sougoula for example, the woody vegetation on non-cultivated lands is denser in 2001 than in 1965. The forest is now managed by Sougoula's Village Association. Commercial cutting by outsiders is not permitted.

In short, land use trends at seven of the nine villages studied showed a pattern of agricultural intensification and natural resource conservation. Several of the villages are managing and conserving their forest resources. The remotely sensed images confirmed that woody vegetation cover is as dense or denser at present than in 1965 for those communities that manage their forest resources. Remote sensing images and tools for their analysis have helped OHVN staff see and monitor the impact of their work to promote the adoption of a variety of natural resource management practices in the zone. In particular, the historical satellite photographs (from the U.S. Corona program) provide a unique baseline for retrospective and time-series studies applicable at local scales throughout Africa.

Discussion

Several problems were encountered during the 2002 activity period. First, the land-use and land-cover trends for the 21 village-based study areas are clear, but an understanding of the driving factors behind these trends is still lacking. Early discussions with OHVN staff indicated that they would conduct a parallel field study in their zones of intervention, in order to characterize the levels of adoption and use of NRM practices for boosting agricultural production, diversification of agricultural products, and for soil and water conservation. They did produce a preliminary ranking of villages according to the level of NRM use, but the survey was incomplete and superficial. The major field survey that we were anticipating had not begun by the end of the 2002 activity period, and as of this writing, it has still not been initiated. Our approach was to examine land-use and land-cover trends for villages that they expect to study (as well as others where OHVN does not have a history of intervention).

The land-use and land-cover trends from this study do present an opportunity for focusing a follow-up field survey on the three distinct types of land-cover trends that we found. The OHVN still plans to work with ICRISAT to conduct a survey to evaluate the level of NRM adoption, the area of land treated, and the enabling conditions that led

farmers to adopt these practices. The survey will not be limited to the Ouelessebougou sector of the OHVN, but is expected to canvass all sectors, including the more semi-arid regions north of Bamako. Having worked out a practical approach to quickly and inexpensively obtain time-series land-use and land-cover trends at the village *terroir* scale, the combination of a traditional field survey (including household interviews, focus groups, etc.) and an image-based assessment would be very informative. Comparing numerous physical and socioeconomic variables in villages where we show continued expansion with those that exhibit stable land use or even a reduction in agricultural land will provide valuable lessons for development practitioners who are promoting NRM techniques.

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Figures

Figure 1. Location of the 12 study villages on the northern part of Burkina's Central Plateau.

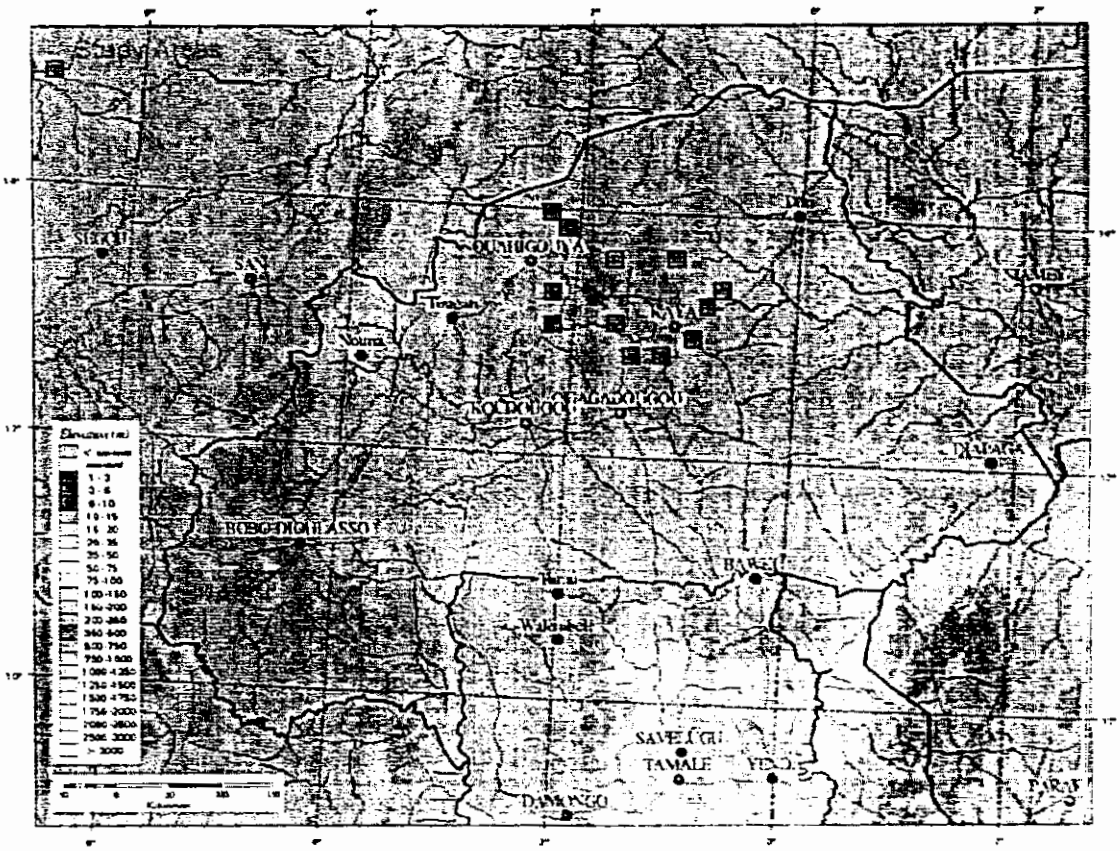


Figure 2. Photograph of planting pits, or *zai*, now used throughout the study area.

Figure 3. Photograph of rock lines or bunds, used to slow runoff, increase infiltration, with the effect of boosting crop yields, trapping topsoil, and promoting natural regeneration of woody vegetation.

Figure 4. Graph of annual average rainfall for Burkina, 1923 to 1999.

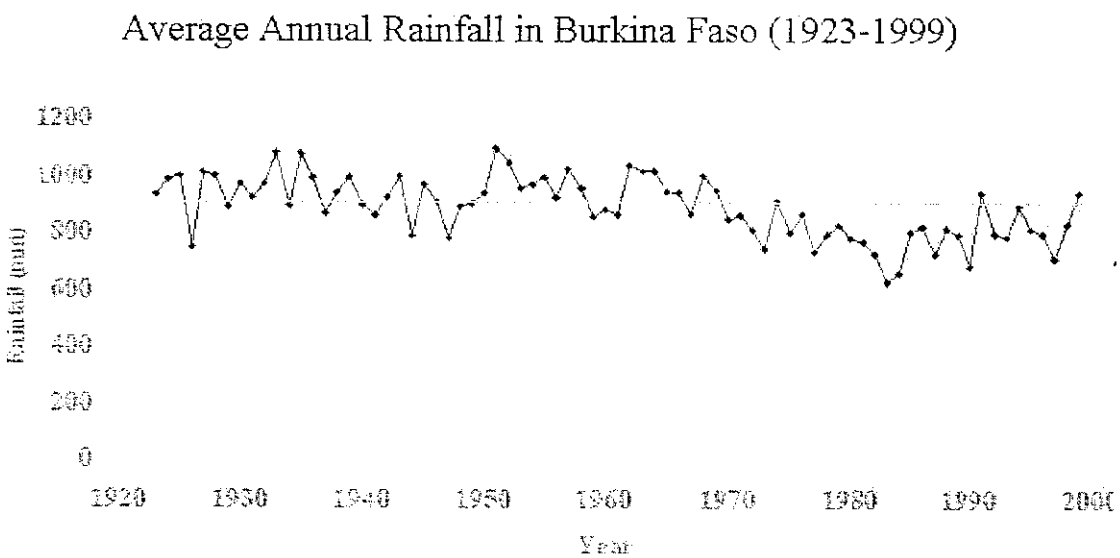


Figure 5. Example of one of approximately 1000 aerial photographs acquired by the project team in June 2002. This photograph was taken over the *terroir* of Noh. The original photo scale was approximately 1:8000. Note that one of the key SWC practices – the use of rock lines or bunds – can be identified and mapped from the photo.

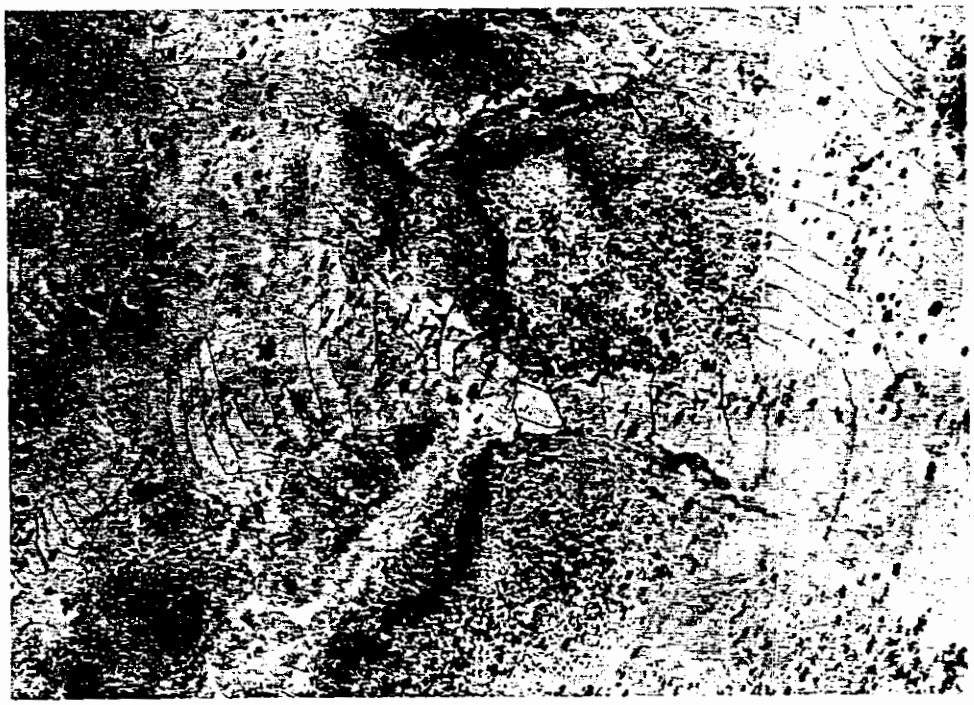


Figure 6. Presentation of the time-series land-use and land-cover maps of the Noh terroir, prepared by the Burkina remote sensing team.

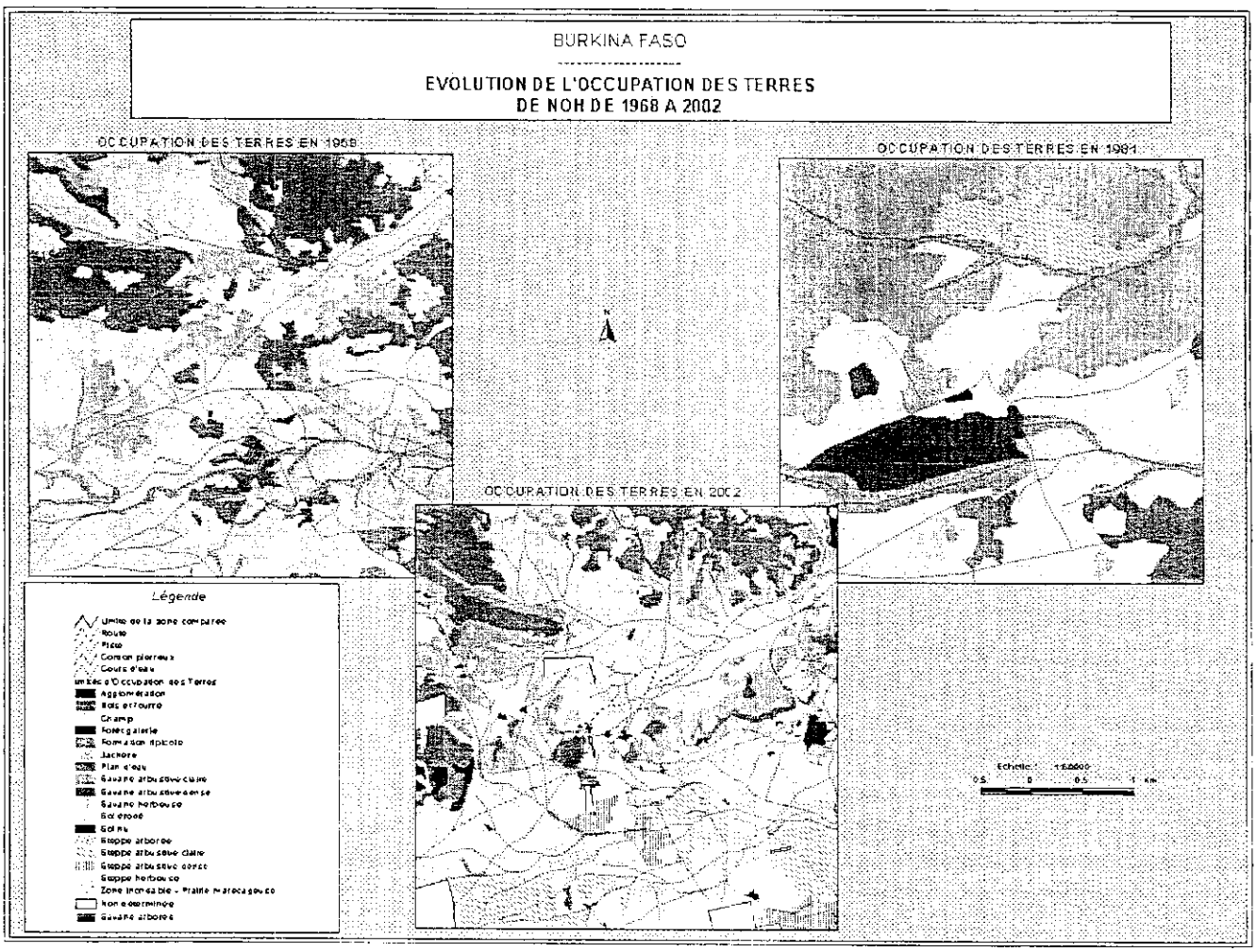


Figure 7. General location of the OHVN Zone study area in southern Mali.

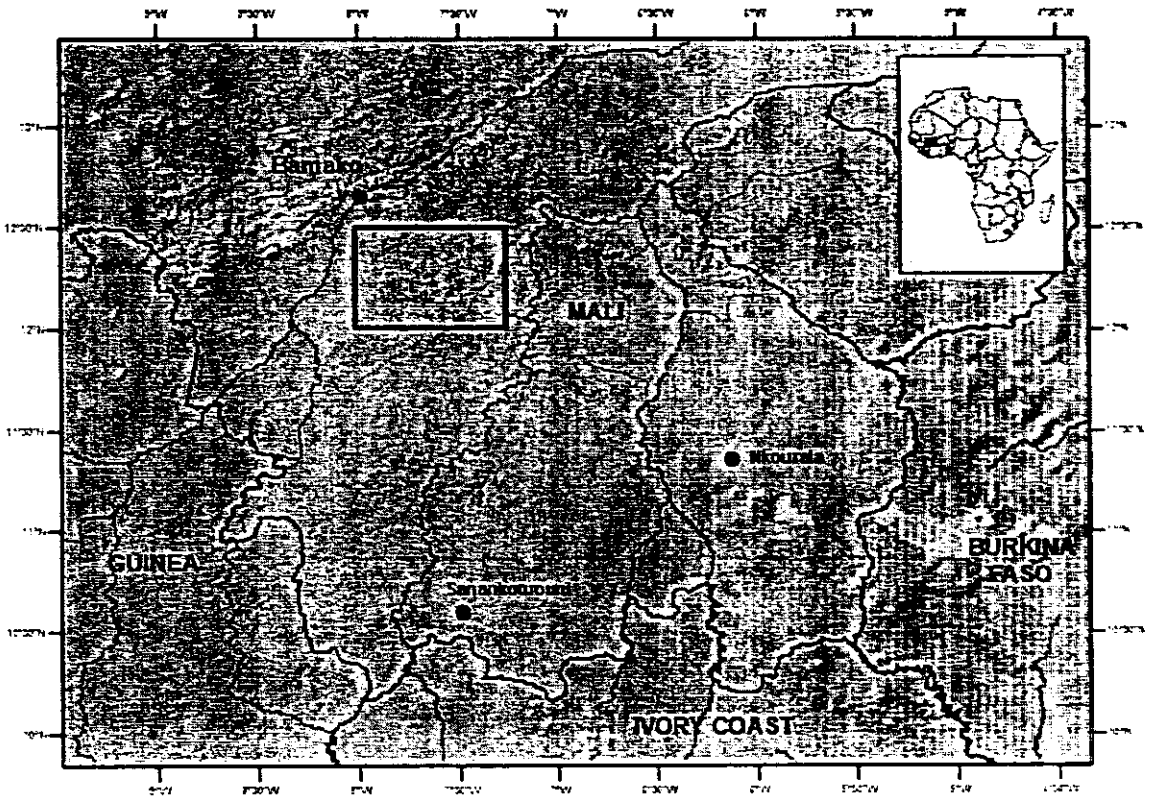


Figure 8. Example of a low-altitude aerial photograph taken over the OHVN study area, southern Mali.

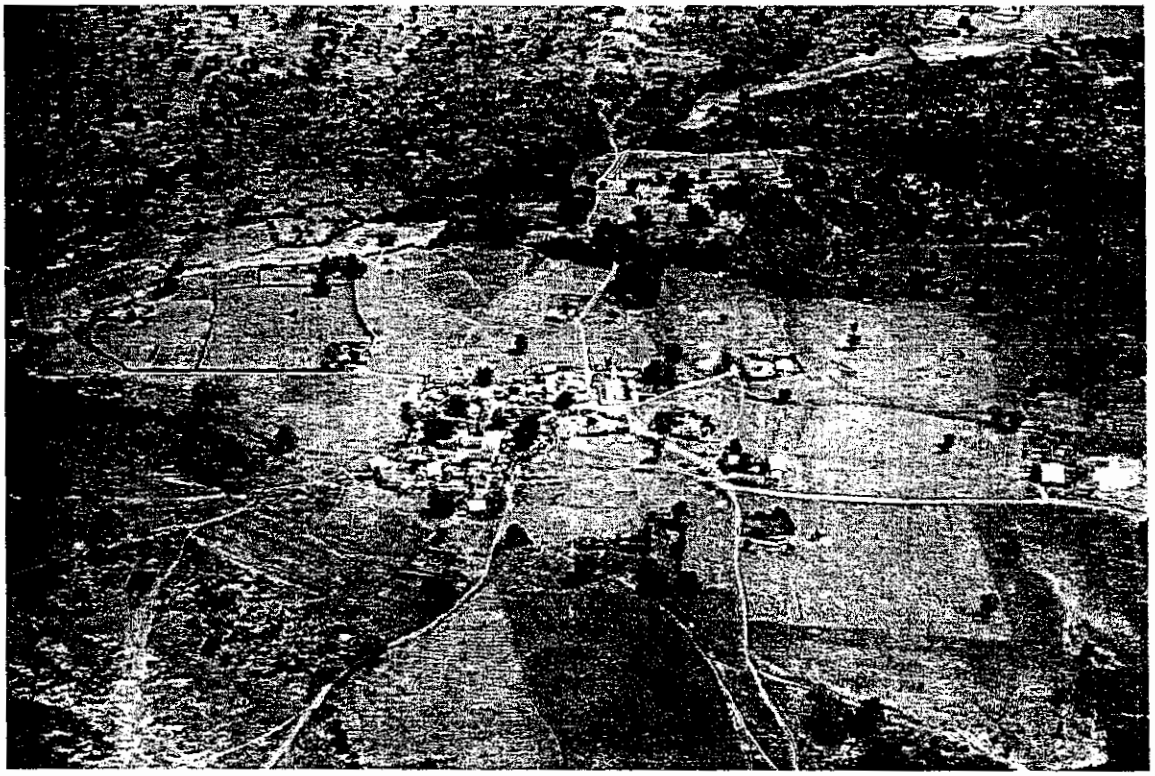
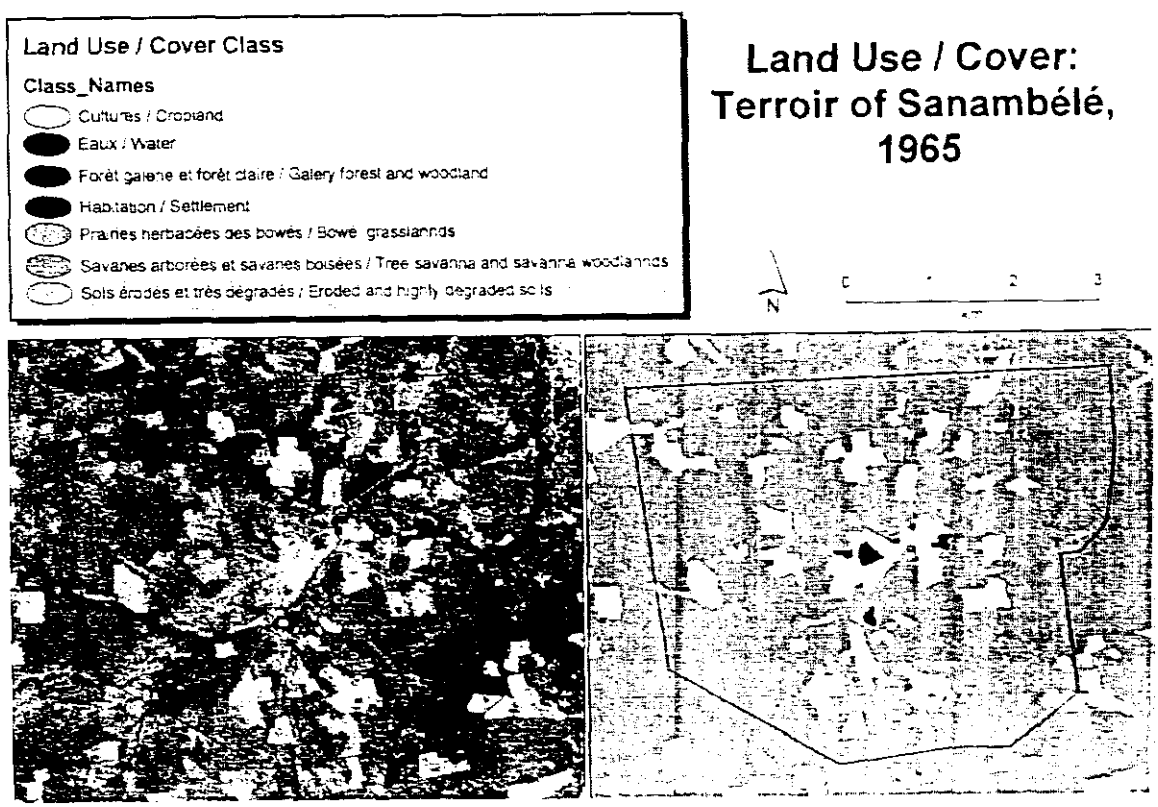


Figure 9. Time-series land-use and land-cover maps of the Sanambele study site. Also show is the Corona and Landsat imagery used in preparing the maps.



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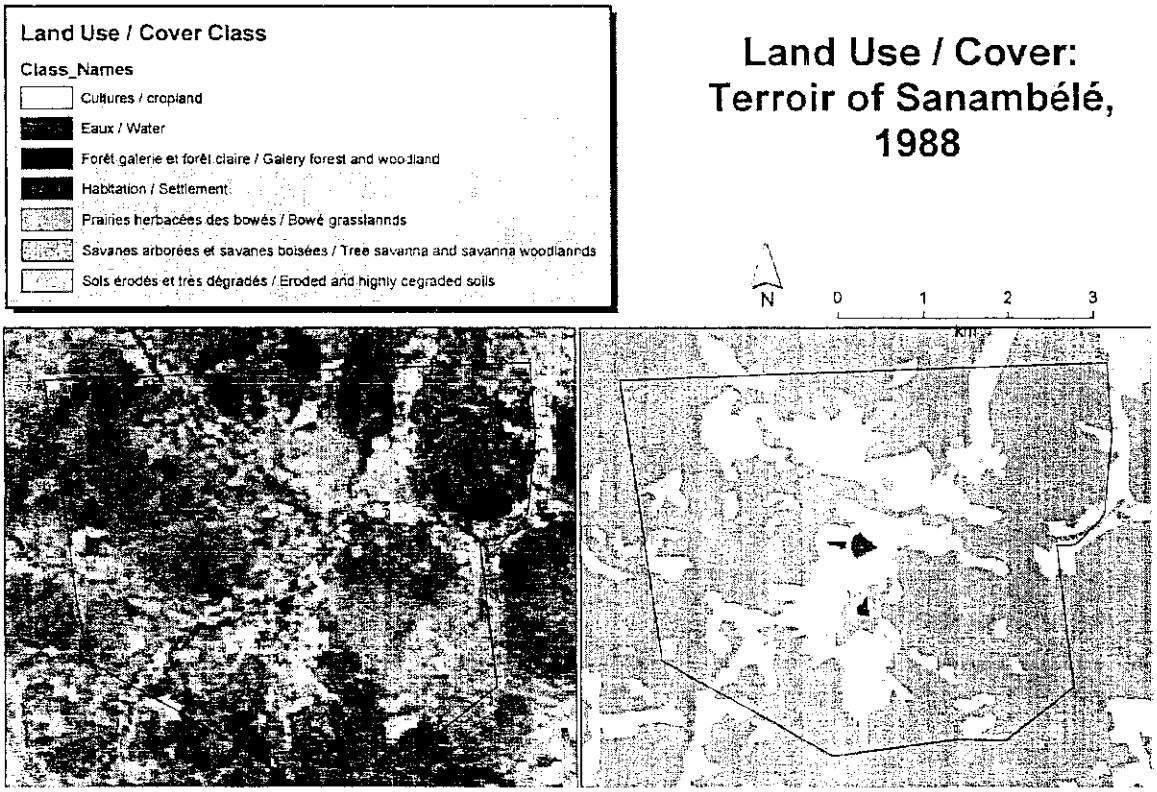
Land Use / Cover: Terroir of Sanambélé, 1988



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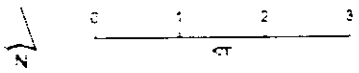
Land Use / Cover Class

Class_Names

- Cultures/ Cropland
- Eaux / Water
- Forêt galerie et forêt claire / Galery forest and woodland
- Habitation / Settlement
- Prairies herbacées des bowés / Bowe grasslannds
- Savanes arborées et savanes boisées / Tree savanna and savanna woodlannds
- Sols érodés et très dégradés / Eroded and highly degraded soils

Land Use / Cover: Terroir of Sanambélé, 1999



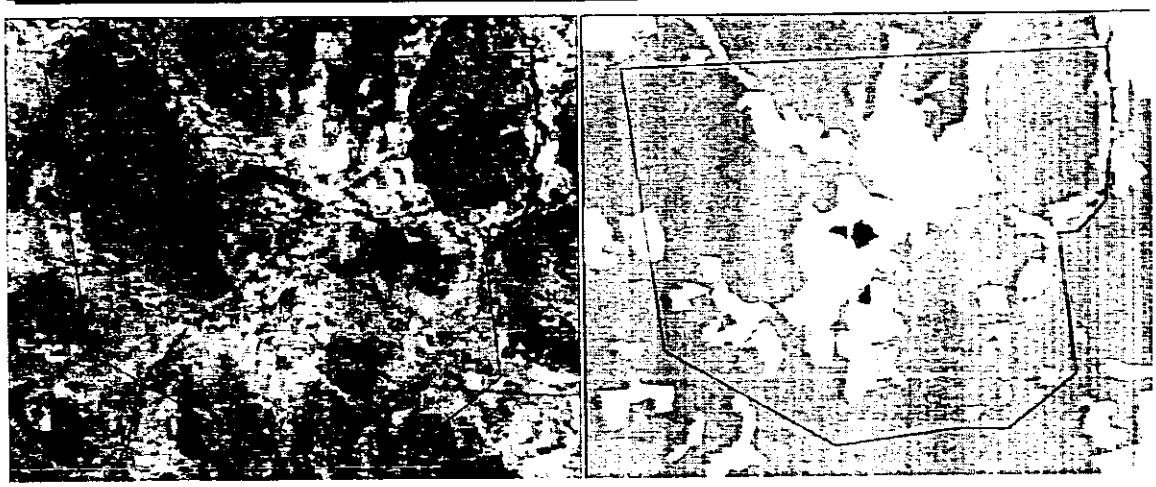
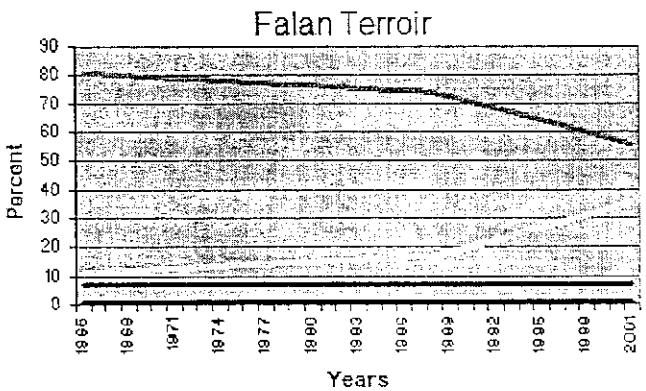
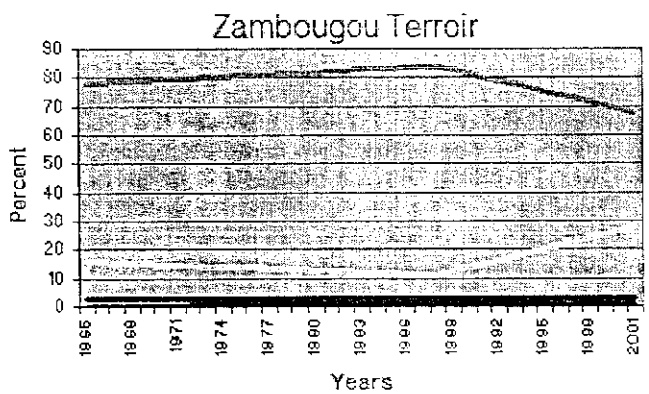


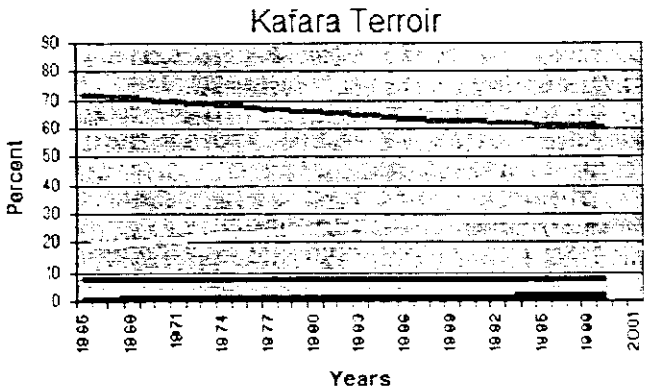
Figure 10. Graphs of land-use and land-cover trends of 6 representative village-based study sites in southern Mali (out of a total of 21 sites). Note the distinctly different land-cover trends as determined by whether cropland is continuing to expand, stabilize, or decrease in area.

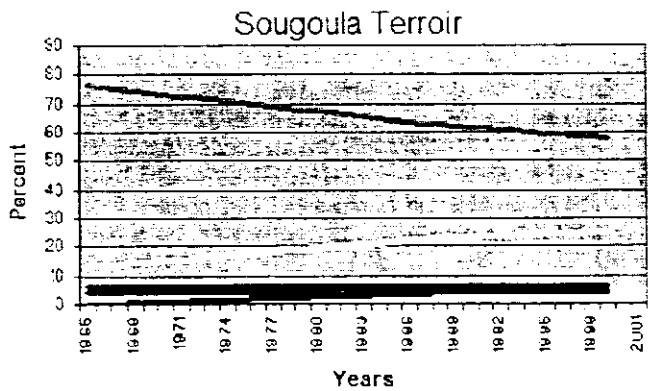
Land-Cover Classifications

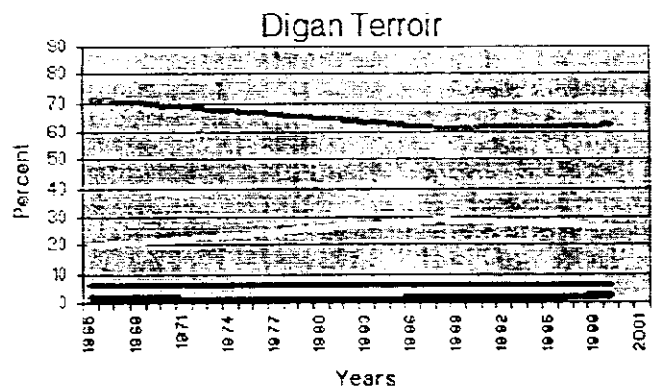
- Natural Vegetation
- Agriculture
- Bowé
- Gallery Forest
- Severe Erosion

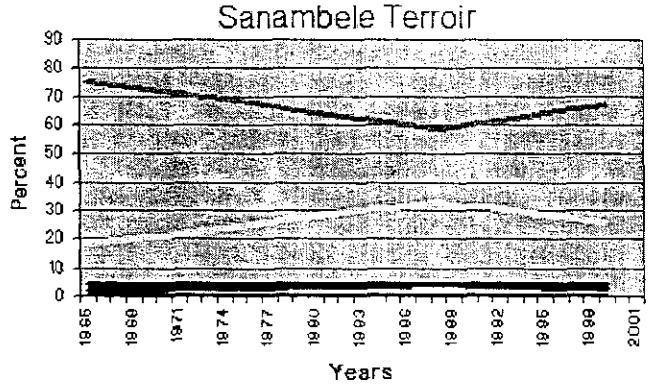





Kafara Terroir
Percent
Years


Sougoula Terroir
Percent
Years


Digan Terroir
Percent
Years



WSSD/Land Cover Performance – NDVI Analysis

The analysis of Normalized Difference Vegetation Index (NDVI) data in support of the land cover performance project will ultimately be composed of three phases. The first phase included a broad investigation of different statistical methods for assessing land performance using the long-term record of coarse resolution (8-km) NDVI imagery. The second phase involves the refinement of these analysis techniques and their application to a finer resolution (1-km) dataset for both Senegal and the Sahel. The third phase will entail the use of these techniques in the analysis of the reprocessed AGRHYMET 1-kilometer NDVI data set. Last year, 2002, marked the completion of phase one and preliminary progress on phase two of the NDVI analysis. The current year has nearly brought phase two activities to completion and the reprocessing of data necessary for phase three is currently underway.

Final results were completed on the use of 8-km NDVI for identifying land production anomalies in the West African Sahel. The completed tasks included: (a) conducting standardized Principal Components Analysis on a set of 18 images of seasonal integrated and maximum NDVI for the years 1982-1999; (b) conducting a method to detect NDVI anomalies that relate to land production variations using a local variance method. This method flagged local clusters of pixels showing anomalous behavior, indicative of either degradation or higher than average vegetation production; (c) conducting a linear regression analysis to test trends in the NDVI time series for the Sahel region using the 18-year data series. The results showed an encouraging positive trend possibly indicating an increase in overall productivity in recent years. Reports and graphics were prepared showing the results of these tasks.

The second phase has focused primarily on refining the local variance analysis technique using 1-km Global AVHRR data and 1-km SPOT Vegetation data. The initial work on three years of Global AVHRR data for Senegal showed promising results, however, the time-series limitations of the data set drove the need to incorporate another 1-km NDVI product made available by the French SPOT Vegetation satellite.

EDC scientists processed SPOT NDVI data for the Sahel region in preparation for time-series analysis of the 1-km data. Using the same local variance technique that was applied to the AVHRR data, the four-year time series of SPOT data was analyzed and results were incorporated with the previous AVHRR analysis. The seven years of data provided much more confidence in the anomaly detection in Senegal. These results were summarized in a poster for presentation at the Pecora 15 Land Satellite Information IV conference held in Denver, Colorado.

EDC scientists further investigated three parameters used in the local variance analysis. They include moving window size, standard deviation threshold, and a limitation on the number of anomalous years necessary to be considered significant. Variability in each of these parameters was assessed to determine how they effect the detection of anomalies of varied sizes, shapes, and types. Knowledge of these effects allows better understanding of possible limitations when applying the local variance technique over large ecologically diverse regions.

Preliminary analysis of the seven year AVHRR/SPOT time series was conducted for the Sahel. The initial examination of the Sahel results focused on the northern portion of the Central Plateau in Burkina Faso and the Upper Niger River Basin in Mali. A number of study sites have been established in these areas to support other land cover performance work. One of the more striking general observations was an area in northeast Burkina where deposition of sand has formed 'fingers' of productive soils running parallel along an east-west tract. Between these sandy depositions, lie bands of unproductive clay soils that allow very little vegetation growth. The local variance technique effectively identifies these bands of alternating productive and non-productive soils as both positive and negative anomalies respectively. Specific investigations of the twelve study sites in Burkina Faso were not as lucrative. While often in proximity to identified anomalies, the study sites showed no strong associations with either positive or negative anomaly locations. Similar results were found for sites in southern Mali. We attribute the inability to distinguish productivity in these areas, using the local variance technique, to issues of scale. Because the study sites are only 1-2 kilometers in size, it is likely that 1-kilometer resolution NDVI is inadequate for detecting these subtle changes in vegetation productivity. This could also result from slight registration problems between data from two different sensors. In the latter case, the use of a consistently processed data set may help to solve problems associated with small-scale anomaly detection using these methods.

As a result of the work in Senegal, a manuscript titled *"Assessing Land Cover Performance in Senegal, West Africa using 1-km Integrated NDVI, Local Variance Analysis, and High Resolution Satellite Imagery"* was prepared for presentation at both the Association of American Geographer's conference and the Dakar Carbon Workshop in March of 2003. Results of the sensitivity analysis and expansion of these techniques to the Sahel were also presented in a training session for carbon workshop participants from a number of West African countries. The results were well received

and interest in utilizing the technique was expressed by colleagues at the *Centre de Suivi Ecologique* (CSE).

In addition to validating results of the Senegal anomaly detection using high resolution Landsat ETM+ imagery and prior field experience, EDC scientists conducted field investigations of specific anomaly locations. Using hardcopy anomaly maps and a global positioning system, investigators were able to locate a number of positive and negative anomaly areas. Digital and film photography was used to document anomalies in the forest reserve and pastoral regions north of Kaffrine, the Ferlo Valley region near Loumbel Lana and Linguere, and areas in the central Peanut Basin.

Preliminary work on quantifying productivity differences within the anomalous areas has been accomplished by spatially averaging integrated NDVI values within a defined area and then graphing the differences between annual integrated values for areas defined by the local variance procedure as either positive, negative, or normal. Additional work is being conducted to identify better methods of quantifying differences in localized land production.

Phase three analysis activity relies on the completed reprocessing of the NDVI archive for West Africa, which is currently underway as a collaborative effort between the AGRHYMET Center in Niamey, Niger and the NASA Goddard Space Flight Center. Once completed, the AGRHYMET data set will provide a consistently processed twelve-year time series of data that will produce even more viable local variance results and allow for the implementation of different trend analysis methods. Trend analysis will provide a temporal aspect to the assessment of land cover performance that we have been lacking with the 1-km data.

Theme 2: AGRHYMET AVHRR/NDVI Processing

A Sun Ultra 60, with 1 Gb memory and two 36 Gb hard drives, was ordered and delivered to the AGRHYMET Regional Center (ARC) in Niamey, Niger. The Sun workstation was acquired to facilitate processing both the archive and operational 1-km AVHRR data.

National Aeronautics and Space Administration (NASA) / Goddard Space Flight Center (GSFC) staff developed (and documented) programs to ingest, process, and calibrate National Oceanic and Atmospheric Administration (NOAA)-11, NOAA-14, and NOAA-16 files from the AVHRR archive at the ARC in level 0 and level 1b. NASA staff have extensive experience in intra- and inter-sensor calibration for the historical record of AVHRR data, as well as for real time operational applications. Staff at EDC developed a Land Analysis System (LAS)-like stand-alone program for ingest of LAS-specific intermediate level 1b formats.

NASA staff traveled to the AGRHYMET Regional Center in Niamey, Niger, to assist in the installation and implementation of the AVHRR processing software. AVHRR data processing software was installed and successfully run for NOAA level 0 and level 1b formats, as well as for the LAS-specific intermediate level 1b format. Differences between NASA and LAS georegistration results for the geographic coordinate system, and procedures for archiving, were resolved. Training was provided to staff at the ARC for processing archived NOAA-11, 14, and 16 data, and operational NOAA-16 data.

Programming staff from the ARC also traveled to GSFC for training on the use and implementation of the GSFC- and EDC-developed software for AVHRR data ingest and NDVI processing. In conjunction with the training at GSFC, computer resources at GSFC were used to expedite processing of the archive AVHRR data from AGRHYMET. AVHRR-NDVI data were processed for 1990-1995, and 1997-2000. NOAA-16 (2001-present) data have yet to be processed at the ARC, and should be completed within the next 3 months. Processed data have been checked (quality control) for consistency and registration errors – some dekadal data will have to be reprocessed and/or manually registered in order to provide better georegistration.

Significant problems/delays related to achievement of objectives were encountered:

1) events of September 11, 2001, resulted in the unavailability of EDC staff for support to this project;
2) events of September 11, 2001, resulted in delays in travel to Niger;
3) changes in staff at the ARC resulted in a major delay because it was learned only after many months that the ARC programmer originally trained on the use of the AVHRR software was not available for processing, requiring training additional staff (from the ARC, by NASA) on the use of the software;
4) delays were encountered while waiting for the ARC to provide archive AVHRR data on DVD for processing at NASA-GSFC.

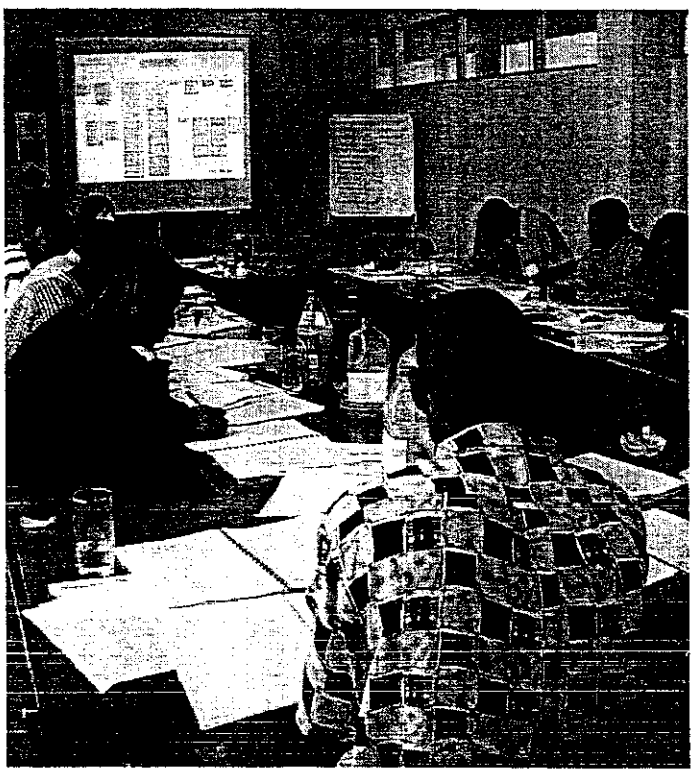
Theme 3: Technical Support to WWF SARPO GIS Strategy

This report summarizes USGS/EDC activities for Theme 3, which is part of the Memorandum of Understanding with IFDC for "Quick Start for Agriculture in Africa". The activities initially were designed for the period of February 15, 2002 to September 30, 2002 to contribute to efforts in Southern Africa for the Geographic Information for Sustainable Development (GISD) initiative leading up to the World Summit on Sustainable Development (WSSD). Amendments dated June 12, 2002 and November 18, 2002 were made to support additional networking among GISD alliance partners, building awareness about technical and institutional frameworks for data sharing and data integration, and strengthening communication among partners to achieve GISD objectives. Under the 2nd amendment, EDC also provided direct expertise to partners to aid in the establish map services and metadata-based clearinghouses.

1. Description of Overall Program:

EDC support to World Wildlife Fund (WWF) Southern Africa Regional Project Office (SARPO) consisted of four activities: (1) EDC worked with WWF in developing a metadata clearinghouse system to facilitate data discovery and communication about data resources; (2) EDC conducted a study that applied available remotely sensed data to environmental monitoring and conservation planning to strengthen existing WWF activities; (3) EDC helped establish linkages and synergies between WWF SARPO activities and other programs in the region; and (4) EDC provided input to EIS-AFRICA's position paper on geo-information for decision-making in Africa that was distributed at the WSSD.

2. Progress or Completion of Components:



Activity (1): EDC, on behalf of World Wildlife Fund (WWF)/Southern African Regional Program Office (SARPO), conducted a week-long metadata, clearinghouse and Internet mapping training course at Zimbabwe's Scientific and Industrial Research and Development (SIRDC) Environment and Remote Sensing Institute (ERSI) in Harare, September 9-13, 2002 (see Attachment A). Fourteen people, representing 7 agencies from both Zimbabwe and Namibia participated in the course (see Attachment B). The participants came from SARPO, SIRDC, Zimbabwe Forestry Commission, SADC Regional Remote Sensing Center, Zimbabwe Survey General's Office, Namibia Directorate of Environmental Affairs (DEA), and Namibia Directorate of Forestry National Remote Sensing Center. In addition to explaining data documentation standards, EDC exposed participants to available metadata tools and resources, and provided a depth of training materials. As part of the training, the participants developed metadata work plans which EDC followed up on in more recent months. As of the completion of this project, March 31, 2003, WWF-SARPO has developed metadata for their data holdings and is about to register a clearinghouse node. They are developing a plan with WWF's headquarters in Gland, Switzerland for the establishment of an Internet map service. The Directorate of Environmental Affairs in Namibia registered its clearinghouse node in March 2003 and

established an Internet map service for the Atlas of Namibia. EDC is continuing to provide clearinghouse and web mapping support to WWF and other institutions in the region through the USAID Regional Center for Southern Africa initiative called Environmental Information for Resource Management (E-INFORM), which started in October 2002.

Activity (2): EDC and WWF agreed to focus on a wildlife monitoring study in Namibia to demonstrate the utility of remotely sensed data as an analytical and predictive tool for conservation planning. The plan was to derive products from satellite imagery to aid in the interpretation of the wildlife census data. Initially, EDC assembled 1 km SPOT Vegetation NDVI data between April 1998 and September 2001, and EDC received a number of geographic data sets, including soils, vegetation, rivers, roads, villages, wildlife census area and wildlife survey results from the project partners in Namibia. EDC integrated these datasets for preliminary visual assessment and to help clarify project objectives and outputs. Over the next three months, and in support of the 2nd annual count wildlife count in Northwest Namibia, EDC mapped survey routes; plotted NDVI and rainfall spatial averages; supplied WWF with maps of cumulative rainfall for the years 2001 and 2002 (October – May) and the date of the last rainfall ≥10 mm on a pixel by pixel basis (Figure 1); and provided WWF with SPOT NDVI for the first 10 days in June 2001 and the cumulative NDVI from Oct – May. EDC met with WWF colleagues in March 2002 in Reston, VA and in April 2002 in Nairobi, Kenya. The remote sensing data products were discussed with WWF staff, and they enabled WWF to identify patterns in the distribution of wildlife counts relative to rainfall.

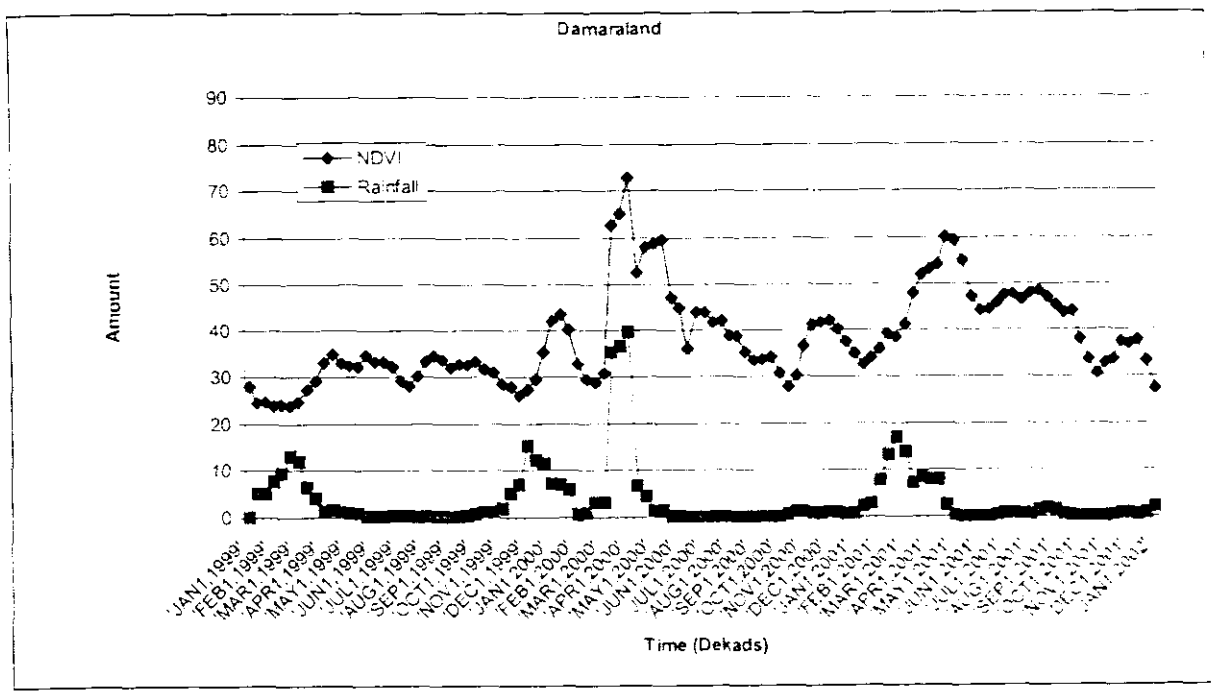
Figure 1. Last rain > 10 mm in 2001 and 2002

2001 2002

These images of the last rain > 10 mm for both 2001 and 2002 are color-coded so that areas where there was no rainfall > 10 mm after Jan 1 are white, and green areas go from light to dark. It data indicates that 2001 and 2002 were very different years (and the wildlife census counts are likely to reflect this). More areas received rain in 2002, but the rains came earlier in the season.

Figure 2 is another sample of EDC's data and analysis support for WWF's wildlife monitoring program. In this graph, spatial averages of rainfall and ndvi are plotted for the province of Damaraland every 10-days. This was done for both 2000 and 2001 and may help explain variations in the census counts.

Figure 2. Spatial averages of rainfall and NDVI for the province of Damaraland.



Activity (3): EDC collected information about potential areas of support and cooperation with WWF, as well as data, reference material, tools, and training and funding opportunities in Southern Africa. EDC regularly supplied WWF with this information to establish linkages and synergies between WWF SARPO activities and other programs in the region.

Activity (4): EDC reviewed the draft recommendations prepared by EIS-Africa and also gathered reports and documents outlining existing information policies and strategies that can serve as examples. Efforts were made to encourage other institutions to endorse the recommendations.
EDC frequently corresponded and interacted with EIS-Africa on information policy issues and mechanisms to increase awareness and obtain high-level political support for geographic information management. Policy related materials that were collected were shared with colleagues in Southern Africa, and Africa as a whole via email.

3. Status of achieving program goals, objectives and benchmarks specified in the annual work plan:

EDC completed each of the project's activities. Furthermore, the activities helped form partnerships that are continuing beyond the completion of the project. In the future, EDC will actively collaborate with national colleagues and regional organizations, in particular Environmental Information Systems-Africa (EIS-Africa), United Nations

Economic Commission for Africa Committee on Development Information (ECA-CODI), OSS/UNITAR – Environmental Information Systems on the Internet (SISEI), FAO-Africover, and the United Nations Environment Programme/Division of Early Warning and Assessment (UNEP/DEWA). These networking efforts are strengthening the community of GIS practitioners who are jointly improving geographic information management and use on the continent.

4. Other accomplishments and major highlights of program implementation:

As WSSD approached, it was clear that a tremendous amount of communication was needed to coordinate activities for WSSD and build a sense of community among the GISD supported projects in Africa. EDC was requested by the USAID/Global Bureau to extend it networking and information sharing efforts from Southern Africa to all of Africa, and USAID/Global Bureau provided additional funds. Thus, EDC and IFDC amended the MOU.

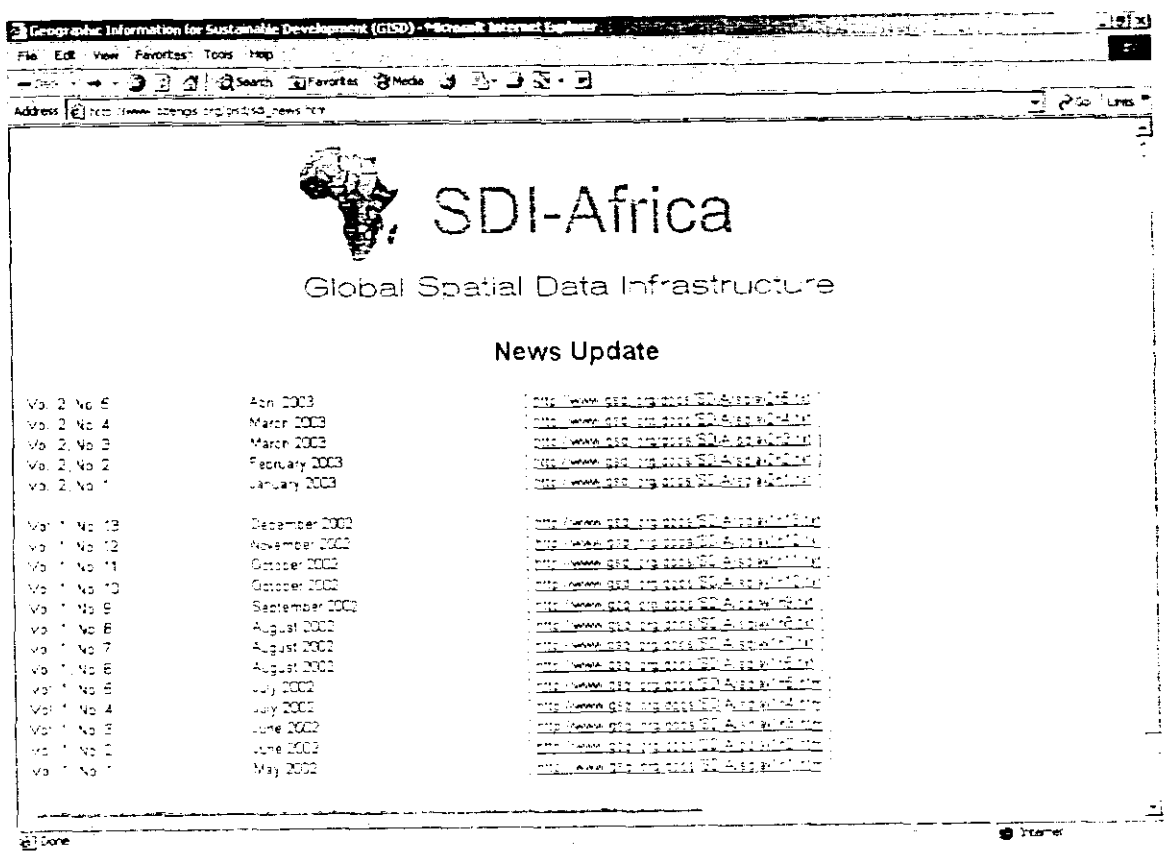
Under the amended MOU, EDC assisted USAID with GISD coordination and contributed to GISD publications. EDC also provided input to OpenGIS Consortium's (OCG) pilot project in Africa, including OGC's presentation at the GISD side event during at WSSD. EDC contributed content and updates pertinent to GISD website, and maintained regular correspondence with GISD partners on data standards and access tools, mechanisms, and policies. EDC, jointly with USAID, organized GISD partner workshops and training in Bamako (March 2002), Asmara (April 2002), Nairobi (April 2002), and Johannesburg (September 2002). EDC developed agendas for these workshops, developed and assembled presentations and other training materials for workshops, and followed up after training on items discussed during the workshops. The Bamako workshop was conducted in collaboration with CGIAR ICRISAT, the Asmara workshop with FAO-Africover, the Nairobi workshop with WWF, and the Johannesburg workshop with CSIR, NSIF, and ESRI. The Bamako, Asmara, and Nairobi workshop included working groups, and the results of the working groups are online at the GISD website[2]. Approximately 120 people in total participated in the workshops (42 in Bamako, 52 in Asmara, 15 Nairobi, 20 in Johannesburg).

In May 2002, EDC started preparing an informal SDI Africa Newsletter, and by the completion of this project, 17 issues were produced and sent out to a mailing list of approximately 950 geospatial specialists in Africa or international specialists working in Africa (95% of the mailing list is African). The newsletter was included at the GISD website[3]. EDC was getting many requests for information from GISD partners and others, so this newsletter was a mechanism to respond to these requests in a more 'collective' manner. The newsletter provided information about data standards, data sources, data access policies, SDI institutional development, funding mechanisms,

2 http://www.opengis.org/gisd/gisdevents.htm
3 http://www.opengis.org/gisd/sdi_news.htm

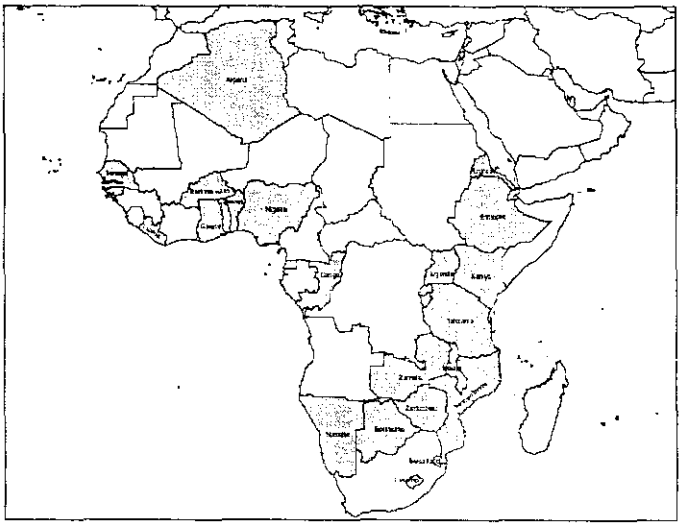
RS/GIS applications, training opportunities, and geospatial projects/initiatives in The newsletter also aimed to increase networking in support of spatial data infrastructure. A number of partners contributed materials, although not as much as EDC would have hoped.

Figure 3. GISD Website: SDI Africa newsletters.



EDC assisted Intergraph and ESRI, two major GIS software vendors, on outreach in Africa for their grant programs (Intergraph's grant program is with OGC focusing on interoperability, and ESRI's grant program is with Global Map and GISD focusing on framework data development). Both grant programs aim to facilitate the availability of core data sets through map services in Africa. Figure 4 provides a summary of the countries that have received the ESRI software donation.

Figure 4. African countries participating in the Global Map/GSDI Grant program as of March 31, 2003.



EDC also worked with ESRI in awarding key regional centers software grants so that they could help with data development and geospatial capacity building.

EDC provided materials to the Nigerian Geospatial Policy Committee to assist with the development of a new policy document that was presented at a 32day Nigeria Geospatial Data Infrastructure Workshop, February 10-12, 2003. EDC gave a presentation on clearinghouse technologies and provided guidelines for start-up activities at the national committee meeting following the workshop.

EDC began development of a Spatial Data Infrastructure Implementation Guide for Africa. The guide is a joint initiative of the United Nations Economic Commission for Africa Committee on Development Information (UNECA-CODI), EIS-AFRICA, Global Spatial Data Infrastructure (GSDI), and EDC. The Guide is based on contributions from a number of selected African geographic information management specialists. EDC prepared terms of reference for African contributors and IFDC administered the contracts with specialists from Senegal, Burkina Faso, Tunisia, Ghana, Benin, Kenya, Zambia, Namibia, and South Africa. An Ad Hoc SDI Experts meeting was held in Addis Ababa, February 4-7, 2003 to review the chapters of the guide. A 'beta' version of the guide will be available for review at the UNECA CODI Conference in May 2003.

Ad Hoc SDI Experts meeting in Addis Ababa, February 4-7, 2003.

A portion of the support to EDC under the MOU amendment also allowed one of EDC's GISD coordinators to co-author the GASSIA Workshop Report (Geospatial Applications to Support Sustainable International Agriculture) with Glenn Hyman from CIAT and Larry Tieszen from EDC[4]. The workshop took place at EROS Data Center, May 19-31, 2002. GASSIA was designed as a collaborative effort of the Consortium for Spatial Information (CSI) of the Consultative Group on International Agricultural Research (CGIAR), the USGS/EDC, the Collaborative Research Support Program (CRSP) and other organizations applying remotely sensed and geospatial data and promoting sustainable international agriculture. In addition to working on the workshop report, the MOU amendment enabled EDC to offer its assistance to CGIAR colleagues in the development of OpenGIS web map services and associated metadata, as follow up to the GASSIA workshop. This included compliance testing on available services and responses to questions regarding technical specifications and implementation. EDC also continued to enhance the MultiViewer that was developed for GISD.

Finally, EDC was available to 'keep the GISD network alive' at a low level, as USAID strived to develop a strategy for GISD after WSSD. In the months following GISD, EDC continued to help build a common 'data infrastructure' vision (largely through communication by email). EDC also participated in discussions of the USAID Geospatial User's Group (Geo-IT Community of Practice), assisted with 'enhancing/web-enabling' USAID agencies and missions through an awareness-raising workshop January 27-29, 2003, and provided materials for the Geo-IT Community of Practice website[5].

5. Identification and explanation of significant problems or delays related to achievement of objectives or activities:

The metadata activity (Activity 1) was slow to get started due to the limited 'readiness' of and response by WWF; just at the project was getting underway, WWF GIS specialist left the organization, which left a gap in staffing. However, once the staffing and 'logistics' issues were sorted out, the work proceeded well, and communication between WWF SARPO and EDC was fluid. Communication between EDC and the WWF office in Harare was aided by assistance provided by Paul Bartel from USAID in organizing several SADC-GIS meetings, in Washington, DC and in Africa.

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4 The complete workshop, including agenda, participants, resource papers, and presentations is available on-line at http://edcintl.cr.usgs.gov/cgiar/pres.html; http://edcintl.cr.usgs.gov/cgiar/gassia.pdf

5 http://forum.usaid.net/forums/gis/index.jsp

ATTACHMENT A

Development of GSDI Clearinghouse Nodes September 9 - 13, 2002 Harare, Zimbabwe					
	MONDAY SEPT 9	**TUESDAY SEPT 10**	**WEDNESDAY SEPT 11**	**THURSDAY SEPT 12**	**FRIDAY SEPT 13**
8:30 - 9:00	-	Metadata Tools	Metadata & ISO Discussion	Ex: MapServer Install	Metadata Workplan Development
9:00 - 9:30	Intro & Welcome	MetaLite	Isite Intro, Isite for Windows, Sample Install	Ex: MapServer Install	GIS Data Provider/User Coordination
9:30 - 10:00	SDI: concepts and components	Ex: Jamaica	Ex: Isite Install	MapServer Sample Install	GIS Data Provider/User Coordination
10:00 - 10:30	Clearinghouse	Ex: Jamaica	Ex: Isite Install	MapServer Sample Install	GIS Data Provider/User Coordination
10:30 - 10:45	Break	Break	Break	Break	Break
10:45 - 11:30	Example Searches & Steps in Creating a Node	Review of Jamaica Metadata	Ex: Test Class Nodes	MapServer OGC Compliance Testing	Final Questions & Answers
11:30- 12:00	Intro to Metadata	Ex: Development of Own Metadata	Ex: Add Class Metadata	Final Technical Questions	Workshop Evaluation
12:00 - 12:30	Graphical Standard (tabs)	Ex: Development of Own Metadata	Options for Serving Metadata	GSDI & SDI Acitivites in Africa	
12:30 - 1:00	Main Sections and Section 1 of Stancard	Ex: Development of Own Metadata	Node Registry	GSDI & SDI Acitivites in Africa	
1:00 - 2:00	Lunch	Lunch	Lunch	Lunch	Lunch
2:00 - 2:30	Ex: Hickory	Metadata Validation	OpenGIS Intro & WSSD Demonstration	Data Sharing Policy & Africa Experience	
2:30 - 3:15	Ex: Hickory	Ex: Validation (admin,jamaica,own)	Clearinghouse and OpenGIS	Data Sharing Policy & Africa Experience	
3:15 - 3:30	Break	Break	Break	Break	
3:30 - 4:00	Ex: Jeopardy	Ex: Validation (admin,jamaica,own)	MapServer Intro and Namibia Example	Metadata Workplan Development	
4:00 - 4:20	Ex: Jeopardy	Ex: Validation (admin,jamaica,own)	Ex: MapServer Gallery	Metadata Workplan Development	

ATTACHMENT B

WWF-ERSI GIS METADATABASE COURSE PARTICIPANTS

(9 – 13 SEPTEMBER 2002)

NAME	ORGANISATION	E-MAIL ADDRESS PHONE
DOMINIC KWESHA	Forestry Commission	dkwesha @ frchigh.co.zw 496-878 9
JULIA MAMBO	Forestry Commission	jtmambo @ frchigh.co.zw 496-878 9
JOSEPH MUCHICHWA	Forestry Commission	jmuchi @ frchigh.co.zw 496-878 9
TENDAYI MANYUMWA	Surveyor General's Office (University of Zimbabwe)	tmanyumwa @ hotmail.com 303-221
STEPHEN NYAUMWE	ERSI-SIRDC	snyaumwe @ sirdc.ac.zw 860-321 (321 through 329), ext. 2043
GEORGE KWENDA	ERSI-SIRDC	gkwenda @ sirdc.ac.zw 860-321 (321 through 329), ext. 2007 2049
LUKE MAROZVA	ERSI-SIRDC	lmarozva @ sirdc.ac.zw 860-321 (321 through 329), ext. 2010
WILSON MUNYARADZI	WWF SARPO	Wmunyaradzi @ wwf.org.zw 252-533 4, 703-902
SAVANIA CHINAMARINGA	WWF SARPO	Sava @ avu.org 252-533 4, 703-902
DOROTHY NYAMHANZA	SADC Regional Remote Sensing Unit	dnyamhanza @ fanr-sadc.co.zw 796-847 8, 736-051 2
FELIX MUYOBA	National Remote Sensing Directorate of Forestry, Namibia	Fmuyoba @ met.gov.na +264 61-221478, +264 61-222830
EMMA NOONGO	Directorate of Environmental Affairs Ministry of Environment & Tourism, Namibia	Enn @ dea.met.gov.na +264 61-249115

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GISD Project
Annex 4

Subcontracts With

Mud Springs Geographers
IFDC Contract # 01592/01

and

Louisana State University
IFDC Contract # 01603/02

1. Project Summary Pages
2. Project Memorandum of Understandings
3. Project Final Reports

	Project Summary Page
MOU Lead Implementation Organization	**3a. Mud Springs Geographers** **3b. LSU**
Contact Person	Dr. John Corbett President Mud Springs Geographics, Inc. 18 South Main Street, Suite 718 Temple, TX 76501, USA Telephone: 254 778-5150 and 254-913-2102 johncorbett@mudsprings.com Dr. Jack Malone DVM Professor Louisiana State University School of Veterinary Medicine South Stadium Road Baton Rouge, LA 70803, USA Telephone: 225 578-9692 malone@mail.vetmet.lsu.edu
Project/Program and Statement of Work	Target Region 2: African Great Lakes: **Spatial Decision Support Systems and Control of SCHISTOSOMASIS in Africa** Mud Springs Geographers and LSU will (1) develop regional-scale geospatial methods to predict variation in risk of schistosomiasis associated with climate, water development and other environmental changes by matching the environmental preferences and limits of tolerance of Schistosoma parasite-snail host systems to the range of thermal-hydrology conditions found within the distribution range of the species found in the Lake Victoria Basin; (2) Create a "HealthWhere" spatial decision support systems module for schistosomiasis based on the ACT software, Schistosoma-snail host distribution data, and a "minimum medical GIS database" ; and (3) Enhance the capacity of scientists at the Kenya Medical Research Institute to develop, validate, and implement spatial decision support systems in national control programs for schistosomiasis. A description of the activities to be undertaken by Mud Springs Geographers and LSU, technical procedures to be followed, deliverables required, and estimated schedule are presented in Attachment 1. Attachment 1 is incorporated as an integral part of this Memorandum of Understanding (MOU).
Collaborating Institutions	KEMRI
IFDC Contract Number	3a. 01599 0201592 01 3b. 01603 02
Budget Amount	3a. Signed contract with Mud Springs for $106,726 on November 9, 2001 3b. Signed contract with LSU for $34,587 on November 30, 2001

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IFDC■01592 01

IFDC INTERNATIONAL FERTILIZER DEVELOPMENT CENTER • MUSCLE SHOALS, ALABAMA 35662 USA
P.O. BOX 2040 • 256-381-6600
EMAIL-general@IFDC.org
TELEFAX NO. 256-381-7408

Memorandum of Understanding

Between

International Fertilizer Development Center
PO Box 2040
Muscle Shoals, AL 35662, USA

And

Mud Springs Geographers, Inc.
18 South Main Street, Suite 718
Temple, TX 76501, USA

October 1, 2001

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2.0 SPECIFIC CONDITIONS

2.1 Effective Dates of MOU

The effective dates of this MOU are October 1, 2001-September 30, 2002.

2.2 Finance

The work to be performed under this MOU is being financed by USAID with all funds channeled to IFDC. IFDC shall provide funding to Mud Springs Geographers, Inc., in accordance with the terms and conditions described in this MOU. Mud Springs Geographers, Inc., shall develop subagreements as necessary to support funding arrangements and the work to be performed by its collaborating institutions. The estimated funds available to Mud Springs Geographers, Inc., total US $106,726 (one hundred six thousand, seven hundred twenty-six) as follows:

Item	Total US $	Total US $
Regional partners and workshops		
Design workshop		
Airfare 4 RT US-Nairobi-US @ $1,400 each	5,600	
4 RT Addis-Nairobi-Addis @ $700 each	2,800	
Lodging 24 room nights @ $100 night	2,400	
M&IE, 32 days @ $50 each	1,600	
Misc (supplies)		
Subtotal, Design workshop		12,400
Kenya Medical Research Institute	4,000	4,000
Personnel		
Admin./Design/Implementation Mud Springs	12,000	
Sr. Programmer	12,000	
Programmer	20,000	
Spatial database technician	10,000	
Fringe benefits	12,150	
Local travel	2,500	
Computer Lab Fee	6,000	
Subtotal, Personnel		74,650
Indirect Costs @ 21%		15,676
TOTAL		**106,726**

NOTE: Individual line item amounts may be exceeded by 10% so long as the total budget is not exceeded.

2.2.1 Use of Funds

IFDC has fiduciary responsibility of funds received from USAID. Under the terms of this MOU, all funds provided to Mud Springs Geographers, Inc., shall be utilized solely for the purposes indicated in the budget under 2.2. Said funds shall cover all expenditures necessary for the services to be performed by and/or arranged by Mud Springs Geographers, Inc. IFDC shall not be responsible for any additional costs (i.e., above US $106,726) incurred in the performance of the work described under this MOU.

2.2.2 Allowable Costs

(a) Mud Springs Geographers, Inc., shall be reimbursed for costs incurred in carrying out the purposes of this MOU, which are reasonable, allocable, and allowable.

(b) Reasonable shall mean those costs that do not exceed those which would be incurred by an ordinarily prudent person in the conduct of normal business.

(c) Allocable shall mean those costs that are necessary to the MOU.

(d) Allowable shall mean those costs which are reasonable and allocable, and which conform to any limitations set forth in this MOU.

(e) Prior to incurring a questionable or unique cost, Mud Springs Geographers, Inc., is encouraged to obtain IFDC's written determination as to whether the cost will be allowable.

2.2.3 Payments

IFDC shall make payments to Mud Springs Geographers, Inc., subject to the receipt of funds from USAID and based upon receipt of an official invoice from Mud Springs Geographers, Inc. The invoice may be faxed to the official IFDC Business Contact indicated in 2.6.1. The payments shall be made on a monthly

basis based upon Mud Springs Geographers, Inc.,' submission of financial reports, which substantiate costs incurred in the performance of this MOU.

2.2.4 Financial Reports

Mud Springs Geographers, Inc., shall provide to IFDC, within 20 days of the end of each month under this program, a financial report indicating funds received from IFDC and funds expended under this MOU.. The financial reports shall include accounting for all allowable costs incurred by Mud Springs Geographers, Inc., under the program in accordance with the line item budget amounts indicated in 2.2. Upon request by USAID, documentation to support all costs incurred under this program shall be made available to IFDC.

2.2.5 Audit

Mud Springs Geographers, Inc., shall maintain books, records, documents, and other evidence in accordance with the usual accounting procedures of Mud Springs Geographers, Inc., to sufficiently substantiate charges to this MOU. IFDC and USAID reserve the right to examine and Mud Springs Geographers, Inc., agrees to make available all financial records and documents of Mud Springs Geographers, Inc., as related to this MOU. Any costs that are determined by either IFDC or USAID to be inconsistent with the terms and conditions of this MOU shall immediately be refunded to IFDC. Mud Springs Geographers, Inc. agrees, subject to a request by USAID, to have an audit performed by an independent accounting firm, of all financial records related to the performance of this MOU. Mud Springs Geographers, Inc., will provide a copy of any required audit report within thirty (30) days of completion of the audit.

2.2.6 Refunds

(a) If Mud Springs Geographers, Inc., earns interest on advances under this MOU prior to expending the funds for program purposes, Mud Springs Geographers, Inc., shall remit the interest to IFDC or deduct the same from subsequent invoices of planned monthly expenditures in accordance with 2.2.3.

(b) Funds not disbursed to Mud Springs Geographers, Inc., at the time the MOU expires or is terminated shall revert to IFDC, except for such funds encumbered by Mud Springs Geographers, Inc., by a legally binding transaction applicable to this MOU. Any funds advanced to but not expended by Mud Springs Geographers, Inc., at the time of expiration or termination of the MOU shall be refunded to IFDC except for such funds encumbered by Mud Springs Geographers, Inc., by a legally binding transaction applicable to this MOU.

(c) If, at any time during the life of the MOU, or as a result of final audit, it is determined that funds provided under this MOU have been expended for purposes not in accordance with the terms of this MOU, Mud Springs Geographers, Inc., shall refund such amount to IFDC.

2.3 Language

The MOU has been executed in English, which shall be the binding and controlling language for interpretation of the terms and conditions of this MOU.

2.4 Subagreements

It is understood that Mud Springs Geographers, Inc., may carryout the work described under this MOU in collaboration with others. It is further understood that funds provided to Mud Springs Geographers, Inc., may be used to support work carried out by collaborating institutions. Mud Springs Geographers, Inc., shall ensure that the specific conditions of this MOU (i.e., Section 2.0, Specific Conditions) shall apply to all such subagreements.

2.5 Revision of MOU Budget

(a) The approved MOU budget is the financial expression of Mud Springs Geographers', Inc., program.

(b) Mud Springs Geographers, Inc., shall immediately request approval from IFDC when there is reason to believe that within the next 30 calendar days a revision of the approved MOU budget will be necessary for any of the following reasons:

- To change the scope or the objectives of the program and or revise the funding allocated among objectives by more than ten percent of the total budget amount unless the schedule states otherwise.
- Additional funding is needed.
- Mud Springs Geographers, Inc., expects the amount of authorized funds to exceed its needs by more than $5,000 or five percent of the MOU budget, whichever is greater. Individual budget lines items may be exceeded by 10% without exceeding the total budget amount under this MOU.

(c) Except as required by other provisions of this MOU specifically stated to be an exception from this provision, IFDC shall not be obligated to reimburse Mud Springs Geographers, Inc., for costs incurred in excess of the total amount obligated under the MOU. Mud Springs Geographers, Inc., shall not be obligated to continue performance under the MOU (including actions under the "Termination Procedures" provision) or otherwise to incur costs in excess of the amount obligated under the MOU, unless and until IFDC has notified Mud Springs Geographers, Inc., in writing that such obligated amount has been increased and has specified the new MOU total amount.

2.6 Other Terms and Conditions

The following terms and conditions, which are applicable to the MOU by and between USAID and IFDC, shall be integral part of this Agreement.

2.6.1 Official Contacts

The contacts under this MOU for all official contacts are as follows:

IFDC Technical
Dr. Lawrence L. Hammond
Director, Research and Development Division
IFDC
PO Box 2040
Muscle Shoals, AL 35662, USA
Telephone: 256/381-6600, extension 270
FAX: 256/381-7408
lhammond@ifdc.org
www.ifdc.org

IFDC Business
Mr. John H. Allgood
Director, Finance, Administration, and Support Services
IFDC
PO Box 2040
Muscle Shoals, AL 35662, USA
Telephone: 256/381-6600, extension 211
FAX: 256/381-7408
jallgood@ifdc.org
www.ifdc.org

Mud Springs Geographers, Inc., Technical/Business
Dr. John Corbett
President
Mud Springs Geographers, Inc.
18 South Main Street, Suite 718
Temple, TX 76501, USA
Telephone: 254/778-5150 and 254-913-2102
johncorbett@mudsprings.com

2.6.2 Publications and Media Releases

If it is Mud Springs Geographers' Inc., intention to identify USAID's contribution to any publication, video or other information/media product resulting from this MOU, Mud Springs Geographers, Inc., shall state that the views expressed by the author(s) do not necessarily reflect those of USAID. Acknowledgements should identify the sponsoring USAID Office and Bureau or Mission as well as USAID substantially as follows:

"This [publication, video or other information/media project (specific)] was made possible through support provided by the Center for Economic Growth and Agricultural Development, Office of Agriculture and Food Security, under the terms of the MOU. The opinions expressed herein are those of the author(s) and do not necessarily reflect the views of USAID."

Mud Springs Geographers, Inc., shall provide the relevant strategic objective or results package team with one copy of all published works developed under this MOU and with lists of other written work produced under the MOU.

Except as otherwise provided in the terms and conditions of the MOU, the author or Mud Springs Geographers, Inc., is free to copyright any books, publications, or other copyrightable materials developed in the course of or under this MOU, but USAID reserves a royalty-free nonexclusive and irrevocable right to reproduce, publish, or otherwise use, and to authorize others to use the work for U.S. Government purposes.

2.6.3 Reports and Data

Mud Springs Geographers, Inc., shall send to the IFDC Technical Contact at the address included in this MOU, monthly and quarterly progress reports in a form and substance satisfactory to IFDC. The monthly reports will provide a brief report on the status of activities being undertaken to implement this project during the previous 30 days.

The quarterly reports shall indicate progress toward achieving Program objectives and implementing approved work plans. The reports shall include, but not be limited to, the following information:

- Status of achievement of program goals, objectives, and benchmarks specified in the annual work plan

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- Progress or completion of components, elements, or activities against planned targets
- Program description
- Other accomplishments or program highlights
- Identification and explanation of significant problems which have been encountered
- Description of planned corrective action

The monthly and quarterly reports may be submitted in electronic format and are to be delivered to IFDC within 7 calendar days and 20 calendar days, respectively, of the end of the reporting period. A final report addressing the same components included in the quarterly report is to be submitted to IFDC by Mud Springs Geographers, Inc., within 45 calendar days of the ending date of this MOU. The reports submitted to Mud Springs Geographers, Inc., to IFDC and supporting materials compiled in performing the services shall be the property of USAID.

Mud Springs Geographers, Inc., is also required to submit copies of reports/publications, produced within each activity as requested by the USAID Cognizant Technical Officer (e.g., workshop proceedings, PowerPoint presentations, etc.).

2.6.4 Termination

This agreement may be terminated, in whole or in part, by either party at any time upon 30 days written notice of termination. Upon receipt of and in accordance with a termination notice from the IFDC, Mud Springs Geographers, Inc., shall take immediate action to cease all expenditures financed by this MOU and to cancel all unliquidated obligations if possible. Further, upon receipt of notice of termination, Mud Springs Geographers, Inc., shall not enter into any further obligations under this MOU. Except as provided below, no further reimbursement shall be made after the effective date of termination. The Mud Springs

Geographers, Inc., shall within 30 days of the effective date of termination repay to IFDC all unexpended funds that are not otherwise obligated by a legally binding transaction applicable to this MOU. Should the funds paid by IFDC to Mud Springs Geographers, Inc., prior to the effective date of termination be insufficient to cover Mud Springs Geographers, Inc.,' obligations in a legally binding transaction, Mud Springs Geographers, Inc., may submit to IFDC within 90 days after the effective date of termination a written claim for such amount. The IFDC shall determine the amount(s) to be paid by IFDC to Mud Springs Geographers, Inc., under such claim in accordance with the "Allowable Costs" provision of this MOU.

2.6.5 Dispute Settlement

Because of the nature of this agreement reconciliation of disputes that cannot be handled amicably will be settled through discussions negotiations by and between the signatories to the MOU.

2.6.6 Investment Promotions

No funds or other support provided hereunder may be used in a program or activity reasonably likely to involve the relocation or expansion outside of the United States of an enterprise located in the United States if non-US production in such relocation or expansion replaces some or all of the production of, and reduces the number of employees at, said enterprise in the United States.

No funds or other support provided hereunder may be used in a program or activity the purpose of which is the establishment or development in a foreign country of any export processing zone or designated area where the labor, environmental, tax, tariff, and safety laws of the country would not apply, without the prior written approval of IFDC.

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No funds or other support provided hereunder may be used in an activity which contributes to the violation of internationally recognized rights of workers in the recipient country including those in any designated zone or area in that country. This provision must be included in all subagreements.

2.6.7 Non-Liability

IFDC does not assume liability for any third party claims for damages arising out of this MOU.

2.6.8 Notices

Any notice given by either party under this MOU shall be sufficient only if in writing and delivered in person or faxed to the official contact persons identified in 2.5.1

2.6.9 Special Provisions

Mud Springs Geographers, Inc., shall comply with USAID environmental regulations (22 CFR Section 216 "Regulation 16") with respect to the activities to be undertaken under this MOU.

2.6.10 Procurement Policies and Procedures

Because USAID is the sole contributor, USAID procurement policies and procedures are applicable (22 CFR Section 226 and ADS 308.5.7a).

2.6.11 *Ineligible Countries*

Activities under this agreement may only be carried out in countries that are eligible to receive assistance under the Foreign Assistance Act. Mud Springs Geographers, Inc., shall provide IFDC in advance a list of those countries where activities are planned under this MOU.

2.6.12 Entire MOU

Unless otherwise specified, this MOU embodies the entire understanding between IFDC and Mud Springs Geographers, Inc., for the services to be provided and any prior to contemporaneous representations, either oral or written, are hereby superseded. No amendments or changes to this MOU, including, without limitation, changes in the statement of work, total estimated cost, and period of performance, shall be effective unless made in writing and signed by authorized representatives of the parties.

FOR AND ON BEHALF OF IFDC

By: J H Allgood

Name: JOHN H. ALLGOOD

Title: DIRECTOR FINANCE & ADMIN.

Date: 11-9-01

FOR AND ON BEHALF OF MUD SPRINGS GEOGRAPHERS, INC.

By: Beau R. Bush for John D. Co PhD President

Name: BEAU R. BUSH

Title: VP OPERATIONS

Date: Nov 13, 2001

WITNESS:

By: L Hammond

Name: LAWRENCE HAMMOND

Title: Director, RDD

Date: 11-9-01

WITNESS:

By: Randal Jeske

Name: Randal J Jeske

Title: Senior Spatial Analyst

Date: Nov 13 2001

IFDC INTERNATIONAL FERTILIZER DEVELOPMENT CENTER • MUSCLE SHOALS, ALABAMA 35662 USA
P.O. BOX 2040 • 256-381-6600
EMAIL-general@IFDC.org
TELEFAX NO. 256-381-7408

Memorandum of Understanding

Between

International Fertilizer Development Center
PO Box 2040
Muscle Shoals, AL 35662, USA

And

Mud Springs Geographers, Inc.
18 South Main Street, Suite 718
Temple, TX 76501, USA

The International Fertilizer Development Center (hereinafter referred to as IFDC) is a public international organization (PIO) dedicated to increasing sustainable agricultural production through the improved use of yield enhancing technologies. Louisiana State University (LSU) and Mud Springs Geographers, Inc., have submitted a proposal to USAID to support development of global spatial models that can be used to predict the effects of environmental change on the risk of schistosomiasis and to guide disease control programs. In order to carryout the work described herein, IFDC and Mud Springs Geographers, Inc., hereby agree to the following terms and conditions:

1.0 INTRODUCTION AND STATEMENT OF WORK

The United States Agency for International Development (USAID) has entered into an Agreement with IFDC for IFDC to undertake a project entitled "Quick Start for Agriculture in Africa" to support the Geographic Information for Sustainable Development (GISD) project leading up to the World Summit on Sustainable Development (WSSD).

IFDC will provide USAID/EGAD AFS with logistical and management support to the various partners involved in the implementation of the GISD project, including transferring and

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providing overall fiscal oversight to specific "pass-through" funds to selected partners who are being asked to implement specific GISD activities. This will include work already identified in specific proposals from the NRC, OGC, and several other groups located in the four Target Regions: Upper Niger Basin, African Great Lakes Region, the Kenya-Tanzania Coastal Zone, and the Limpopo/Zambeze River Basin Region of southern Africa.

IFDC will work in close collaboration with the technical officers within USAID providing oversight: Note: The Overall Coordinator is Robert E. Ford, AEMD – Agricultural Enterprise and Market Development Division within USAID's office of Agriculture and Food Security. Robert E. Ford is the Chair of the GISD-IWG for Regional Applications sub-group.

Close coordination must also occur with co-Chairs of the GISD-IWG for each sub-region. They are: Barbara Best (G/ENV) for the Kenya-Tanzania CZM Activity; Paul Bartel and Jon Anderson (AFR-SD) for the Four Corners/Limpopo/Zambezi Basin region; Robert Ford for the Great Lakes/Great Horn of Africa Region; and Mike McGahuey (USAID/AFR-SD).

Mud Springs Geographers, Inc., and Louisiana State University (LSU) will (1) develop regional-scale geospatial methods to predict variation in risk of schistosomiasis associated with climate, water development and other environmental changes by matching the environmental preferences and limits of tolerance of Schistosoma parasite-snail host systems to the range of thermal-hydrology conditions found within the distribution range of the species found in the Lake Victoria Basin; (2) Create a "HealthWhere" spatial decision support systems module for schistosomiasis based on the ACT software, Schistosoma-snail host distribution data, and a "minimum medical GIS database" ; and (3) Enhance the capacity of scientists at the Kenya Medical Research Institute to develop, validate, and implement spatial decision support systems in national control programs for schistosomiasis. A description of the activities to be undertaken by Mud Springs Geographers, Inc., and LSU, technical procedures to be followed, deliverables required, and estimated schedule are presented in Attachment 1, which is incorporated as an integral part of this Memorandum of Understanding (MOU).

DRAFT PROPOSAL DRAFT PROPOSAL

Schistosomiasis (LSU-Mud Springs Geographers Project) – East Africa

IX. Spatial decision support systems and control of schistosomiasis in Africa

Principal investigators:
Dr. Jack Malone, DVM, PhD, Professor, Louisiana State University, School of Veterinary Medicine, South Stadium Road, Baton Rouge, LA 70803 tel: 225-578-9692 malone@mail.vetmed.lsu.edu
Dr. John Corbett, President, Mud Springs Geographers, Inc., 18 South Main St. Suite 718 Temple Texas 76501, tel 254-778-5150 or 254-913-2102 johncorbett@mudsprings.com

The long-range aim of these studies is to develop global geospatial models that can be used to predict the effects of environmental change on risk of schistosomiasis and to guide disease control programs. This will be accomplished by use of earth observing satellite sensor data and geographic information systems (GIS) global resource data, with climate and agroecologic geospatial databases, to define the environmental preferences and limits of tolerance of *Schistosoma* parasite-snail host systems. Definition of regional environments and local 'type' habitat characteristics of *Schistosoma* parasite-snail host systems will enable development of spatial decision support systems (SDSS) that can be used to predict schistosomiasis risk associated with water development projects and other environmental changes.

In proposed work, SDSS software for schistosomiasis will be developed for the Lake Victoria Basin in Southwest Kenya, Southwest Uganda and Northwest Rwanda. Regional resource databases previously developed on *Schistosoma*-snail host systems (Domenge et al., 1987, Brown, 1995), a '*minimum* medical GIS database' (Malone et al, 2001a) and the USAID Africa Country Almanac series, with the 'MetWhere' module (Corbett et al., 2001), will be further developed to create an operational 'HealthWhere' spatial decision support system that can be accessed by medical investigators and national control program officers by CDROM. Construction of data resources by similar methods (Malone et al., 2001b; Kristensen et al., 2001) will allow future seamless incorporation of results with those from other regions. A successful system can later be linked to rapid medical surveillance methods that are compatible with geospatial databases (Bergquist, 2001) and its use promoted via training programs and a recently established network of medical and earth scientists dedicated to use of SDSS for schistosomiasis control (Malone et al., 2001; www.GnosisGIS.org). The project will develop an operational medical GIS research capability of colleagues working at the Kenya Medical Research Institute and will utilize data developed as part of earlier NIH, USAID and Rockefeller Foundation projects by JB Malone (LSU) and by Gerald Mkoji (KEMRI) and ES Loker (University of New Mexico).

Geospatial models for schistosomiasis will be developed by:

- Incorporation of additional agroecological data from the Africa Country Database Series (ACT), including long term standard climate station databases and products of 'MetWhere' module analysis methods
- Development of models for each parasite-snail host system independently, and
- Use of a dekad-by-dekad analysis of NDVI-Tmax satellite data, with climate data from other sources, to develop a climate-based forecast system for schistosomiasis, including identification of short term life cycle-limiting seasonal high or low temperatures (Appleton, 1977) on the major schistosome-snail host systems that occur in the region.

A design workshop (3-4 day) will be held at KEMRI in Nairobi at the initial phases of the project to enable project co-

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investigators and health agency workers from Kenya, Uganda and Rwanda to exchange data, to discuss results of model development, and to provide for collaborative effort on application of new developments resulting from project work. A second workshop will be held in July, 2002 to provide instruction to health agency personnel and other researchers on use of the initial version of the HealthWhere software module for schistosomiasis. Special focus will be on predicting disease risk associated with new water development schemes. Project results will be reported at the September, 2002 WSSD meetings in Johannesburg, South Africa.

Summary of objectives

1. Develop regional-scale geospatial methods to predict variation in risk of schistosomiasis associated with climate, water development and other environmental changes by matching the environmental preferences and limits of tolerance of *Schistosoma* parasite-snail host systems to the range of thermal-hydrology conditions found within the distribution range of the species found in the Lake Victoria Basin.
2. Create a 'Healthwhere' spatial decision support systems module for schistosomiasis based on the ACT software, *Schistosoma*-snail host distribution data, and a 'minimum medical GIS database'.
3. Enhance the capacity of scientists at the Kenya Medical Research Institute to develop, validate, and implement spatial decision support systems in national control programs for schistosomiasis.]

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* CIMMYT, Mexico City (International Maize and Wheat Improvement Center)

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Budget:

Budget Section 1: LSU

LSU Budget (@ 26% Off Campus Rate for Overhead)

			Requested Funds	LSU Cost Share*
Personnel				
John B Malone	10%			$8,328
Research assistant:		50%		$18,000
Fringe Benefits (22%)			$3,960	$1,874
Local Travel				$2,500
Supplies			$2,000	
Operating Services (Phone, FAX, FEDEX etc)			$1,000	
Total Direct Costs				$27,450 $10,202
Facilities & Adminstrative Costs (@26% off-campus rate)			$7,137	$2,653
Total Section 1: Project Costs to LSU			**$34,587**	**$12,855**

*No Cost to project for Dr Malone's salary

Budget Section 2: Regional partners and workshops (managed by Mud Springs Geographers, Inc.):

Travel to regional workshops: the *design* workshop and the *delivery* (capacity building) workshop.

Design workshop (to take place immediately after contract initiation):

Venue KEMRI, Nairobi

Airfare: $1,400 times 2 persons from USA to Nairobi $2800	
$700 times 2 persons Addis to Nairobi	$1400
Hotel (3 nights, 4 persons = 12 room-nights)	$1200
Per Diem (4 days, 4 persons = 16 days)	$800
Miscellaneous costs (visas, supplies, etc.)	$500

Total for design meeting:
$6, 200

Regional Site SubContracts (for computer/software, local data collection and analysis)

Kenya Medical Research Institute	$4,000	
Total for Regional Site SubContracts:		***$4,000***

Capacity building workshop (to take place July 2002): venue Nairobi

Airfare: $1,400 times 2 persons from USA to Nairobi $2800	
$700 times 2 persons Addis to Nairobi	$1400
Hotel (3 nights, 4 persons = 12 room-nights)	$1200
Per Diem (4 days, 4 persons = 16 days)	$800
Miscellaneous costs (visas, supplies, etc.)	$500

Total for capacity building meeting:
$6, 200

Total Section 2: Regional partners and research and development workshops ***$16,400***

Budget Section 3: Mud Springs Geographers, Inc.

Personnel (workshops, HealthWhere module development)		
Administration / design / implementation (Corbett)	$12,000	
Senior Programmer:	$12,000	
Programmer	$20,000	
Spatial Database technician	$10,000	
Fringe Benefits on labor (22.5%)	$12,150	
Local Travel	$2,500	
Computer laboratory fee	$6,000	
Total Direct Costs	$74,650	
Mud Springs Geographers, Inc. Indirect Costs (21%)	$15,676	
Total Section 3: Project Costs to Mud Springs Geographers, Inc.		**$90,326**

Grand Total ($34,587 + $16,400 + $90,326)
$141,313

Spatial decision support systems and control of Schistosomiasis in Africa

The long-range aim of proposed studies is to develop global geospatial models that can be used to predict the effects of environmental change on risk of schistosomiasis and to guide disease control programs. This will be accomplished by use of earth observing satellite sensor data and geographic information systems (GIS) global resource data, with climate and agroecologic geospatial databases, to define the environmental preferences and limits of tolerance of *Schistosoma* parasite-snail host systems. Definition of regional environments and local 'type' habitat characteristics of *Schistosoma* parasite-snail

host systems will enable development of spatial decision support systems (SDSS) that can be used to predict schistosomiasis risk associated with water development projects and other environmental changes.

In proposed work, spatial decision support systems software for schistosomiasis will be developed and validated in divergent environments in East Africa. Regional resource databases previously developed on *Schistosoma*-snail host systems (WHO, 1987, Brown, 1995), a 'minimum medical GIS database' (Malone et al, 2001a) and the USAID Africa Country Almanac series (Corbett et al., 2001) will be further developed to create an operational 'Healthwhere' spatial decision support system that can be accessed by medical investigators and national control program officers by CDROM. Construction of data resources by similar methods (Malone et al., 2001b; Kristensen et al., 2001) will allow future seamless incorporation of regional results into a comprehensive global system. A successful system can later be linked to rapid medical surveillance methods that are compatible with geospatial databases (Bergquist, 2001) and its use promoted via training programs and a recently established network of medical and earth scientists dedicated to use of geospatial models and medical information systems for schistosomiasis risk assessment and control (Malone et al., 2001).

Specific Objectives:

1. Develop regional-scale geospatial methods to predict variation in risk of schistosomiasis associated with climate, water developments and other environmental changes by matching the environmental preferences and limits of tolerance of *Schistosoma* parasite-snail host systems to the range of thermal-hydrology conditions found within the distribution range of the major species found in east, west and southern Africa.

2. Create an operational 'Healthwhere' spatial decision support systems module for schistosomiasis epidemiological assessment and control program management by health workers in Africa, based on the USAID African Country Database series and associated software, available *Schistosoma*-snail host distribution data, and a 'minimum medical GIS database' for each region.

3. Enhance the capacity of scientists at collaborating regional centers in east Africa to develop, validate, and facilitate implementation of spatial decision support systems in national control programs for schistosomiasis.

Background and Significance:

Widely used for agricultural and environmental purposes, there is growing interest in development of spatial decision support systems for medical applications (Beck et al., 2000). Global geospatial databases available in digital form are a rapidly expanding environmental data resource. Satellite sensor data and agroecologic databases can be stored and accessed electronically and global climate databases can be combined with satellite sensor data to create climate surfaces that may have far greater utility than traditional climate station data. Archival satellite data is available for the last two-three decades and new generation earth observing satellite systems promise greatly expanded new sensor capabilities (Huh and Malone, 2001). For the first time, many excellent current and historical local disease investigations can be systematically and accurately placed in a broad geographical, ecological and temporal context.

The availability of image analysis and GIS computer software packages suitable for use on desktop computers has led to application of this technology to vector-borne diseases and other diseases with strong geographic determinants. In early work on Rift Valley fever, mosquito vector habitats in East Africa were characterized (Linthicum et al, 1987) and related to disease based on satellite sensor-derived normalized difference vegetation index (NDVI) and radar data, and historical outbreaks of this disease were recently linked to climate variability associated with the El Nino Southern Oscillation (Linthicum et

al., 1999). For trypanosomiasis, a successful climate risk model was developed for Southern Africa based on historical biologic data on *Trypanosoma* spp., climate data and NDVI (Rogers and Randolph, 1993; Rogers et al., 2000). 'Health maps', created using GIS, have received new emphasis as part of recent malaria initiatives of the World Health Organization, the National Institutes of Health and European counterpart agencies. Applications have included identification of villages at high risk of malaria transmission by use of local scale Landsat satellite data parameters with distance and buffer analysis of mapped risk factors (Beck et al., 1994) and regional scale analysis of AVHRR sensor data to identify high risk zones (Thomson et al, 1999). Other medical and veterinary applications include Lyme disease (Kitron et al., 1992), onchocerciasis (Richards, 1993), leishmaniasis (Cross et al., 1998), bancroftian filariasis (Thompson et al., 1996; Crombie, et al., 1999), and snail-borne diseases caused by *Schistosoma* and *Fasciola*.

Snail borne diseases are amenable to the use of existing satellite data resources - perhaps more than other more environmentally sensitive, fractious diseases, such as mosquito borne malaria or arboviruses - because annual biological cycles and transmission patterns are slower, with more stable habitats and generational development times of 2-3/year. Two week sampling intervals are accepted by malacologists as adequate for most studies on population dynamics in the field. Thus dekadal (10-day average) satellite sensor and climate data often used by crop scientists and the temporal resolution (earth orbit cycle interval) of current high-resolution satellite systems are acceptable for many studies on the distribution and abundance of schistosome-snail systems. Field and laboratory data on intramolluscan development rates of *S. mansoni and S. haematobium* are available for use in model development (Pfluger 1980, 1981; Pfluger et al.,1984; Shiff, 1964; Shiff et al., 1975; Appleton, 1977, 1978, 1998; Appleton and Ericsson, 1984). Although key to understanding and mapping factors that affect propagation and transmission of schistosomiasis, knowledge is more limited on developmental requirements of the major snail vectors in Africa that determine the distribution and abundance of snail hosts.

Concepts leading to the current proposal were developed as part of studies on use of climate and environmental satellites to define thermal-hydrology domains that reflect risk of snail-borne disease in Egypt, Ethiopia, Zimbabwe, Brazil, Bolivia and China (Abdel Rahman et al., 2001; Fuentes et al., 2001; Malone et al., 1998, 2001; Malone and Yilma, 1998; Bavia et al., 1998, 2001; Mukaratirwa et al., 2000; Yilma et al., 2001; Zhou et al., 2001). Agro-climatic databases used by crop ecologists (Velthuizen and Verelst, 1995) were reported to be useful for characterizing areas endemic for *S. mansoni* in Ethiopia (Yilma et al., 2001). Other studies in Ethiopia (Malone et al., 2001) and Zimbabwe (Mukaratirwa et al., 2000) support the potential value of satellite data as surrogates of temperature and moisture climate data to define the environmental preferences and limits of tolerance of schistosomiasis snail host-parasite systems.

We propose to use global geospatial data resources and GIS methods to: 1) develop spatial decision support systems (SDSS) for health officers in planning and monitoring control programs and, 2) to predict the effects of anthropogenic and natural environmental change on the disease. Predicting the medical consequences of water development projects, in particular, has remained an elusive goal. In recent experience, explosive increases in schistosomiasis occurred following construction of the Diama Dam and related developments in Senegal, even with the benefit of an impact study that predicted the contrary (Southgate, 1997). In many other water development projects, especially smaller dams, health implications are not considered and better means of providing 'Infectious Disease Impact Statements' are needed (McSweegan, 1996).

Research Design and Methods:

Using GIS methods, it is possible to take two approaches to define the relative suitability of the environment for propagation and transmission of vector borne diseases. One approach is to map available

field data on parasite infection prevalence and the distribution and abundance of the vector(s) within a GIS and then allow the parasite to 'define itself' as to its environmental preferences and limits of tolerance by iteratively fitting its distribution to the environmental features found where the parasite is known to exist. A second approach is to define mapped features of the environment that correspond to data from laboratory and field studies on the abiotic preferences and limits of tolerance that drive the life cycles of the parasite and its vector. If valid, models developed by either approach would be expected to be consistent in mapped result, whether climatologic parameters or environmental satellite sensor data are used. A combination of both approaches will be used in proposed work.

Prior results in divergent environmental areas, each with unique schistosome-snail systems, suggest that environmental databases can be used to develop regional and, ultimately, global GIS risk assessment and control models for schistosomiasis using similar GIS input data and protocols. Proposed studies will be done by similar methods in cooperation with regional collaborators in Ethiopia (Addis Ababa University) and Kenya (Kenya Medical Research Institute). Model 'fit' will be tested using data from selected water development sites where well-documented studies exist on colonization by schistosome-snail host systems that also occur in other regions. The resulting SDSS will be used for more focused studies aimed at predicting consequences of proposed water development sites in the Upper Nile Basin in East Africa.

Initially, we propose to develop and validate geospatial models for schistosomiasis in Eastern Africa by:

- Incorporation of additional agroecological data from the Africa Country Database Series, including long term standard climate station databases and products of 'MetWhere' module analysis methods
- Development of models for each parasite-snail host system independently, and
- Use of a dekad-by-dekad analysis of NDVI-Tmax satellite data, with climate data from other sources, to develop a climate-based forecast system for schistosomiasis, including identification of short term life cycle-limiting seasonal high or low temperatures on the major schistosome-snail host systems that occur (Appleton, 1977).

Species to be studied will include the major *Biomphalaria* spp. vectors of *S. mansoni* (*B. pfeifferi, B. alexandrina, B. sudanica, B.* choanamphala), and the *Bulinus* vectors of *S. haematobium* (*B. globosus, B truncatus, B. abyssinicus, B. africanus, B. nasutus*). The prediction models will be based on environmental requirements where conditions are suitable for both potential snail hosts and intramolluscan stages of *S. mansoni* and *S. haematobium* at regional scales.

GIS databases, methodologies and models will be developed based on a minimum medical database (MMDb) developed for the IGAD region of east Africa as part of earlier work (Malone et al., 2001). The MMDb (Figure 1) includes mainly public domain environmental databases and schistosomiasis prevalence and snail host data from WHO and other published sources used for development of the current Ethiopia GIS risk model. It was used for preliminary extrapolation of Ethiopia results to the entire East Africa region (Figure 2a,b). Considered to be fundamental to medical GIS applications on vector-borne diseases, a similar database is currently under construction for use in the SADC region and for West Africa using a small grant from the Rockefeller Foundation Bellagio Fund. The MMDb for each region will be provided to project collaborators for further interactive development. Collaborators at the east African regional sites will validate and further develop provisional regional GIS models by incorporation of locally available data, including: 1) national control program data and 'gray literature' reports on schistosomiasis, and 2) a 'snail host layer' using available in-house collections records, data provided by colleagues from other malacology collections (e.g. Danish Bilharziasis Laboratory, London

Natural History Museum; Philadelphia Academy of Science), key reference books (Brown, 1994; Appleton, 1998) and literature reports.

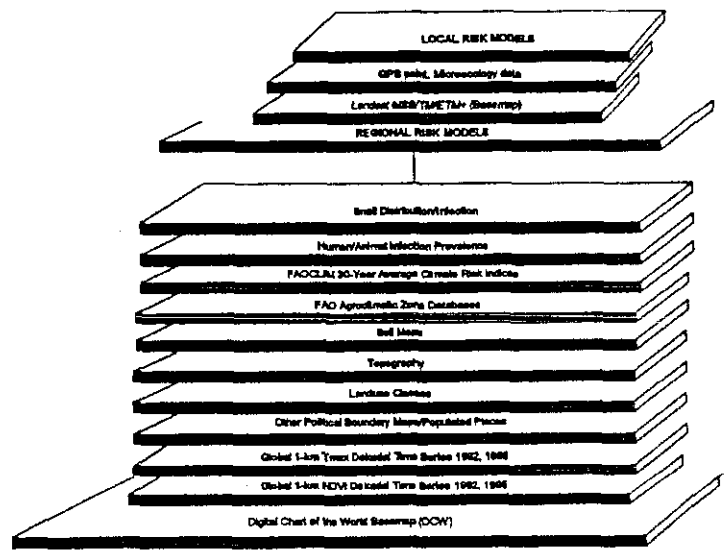


Fig 1. Minimum Medical GIS Database

Regional databases will be used to study and characterize the environment at existing water development projects where it is already known what snail-schistosome systems are established, then used to make model predictions on consequences on schistosomiasis at proposed water development sites. The following means of analysis will be studied in efforts to develop regional risk models:

RELATIONSHIP OF AVHRR THERMAL-HYDROLOGIC DOMAINS TO SCHISTOSOMIASIS USING GLOBAL LAND 1-KM DATABASES – *TO CONFIRM AND EXTEND EARLIER RESULTS FROM ETHIOPIA AND ZIMBABWE, CURRENT GIS MODELS WILL BE FURTHER DEVELOPED BY USE OF ENVIRONMENTAL SATELLITE DATA FROM THE USGS GLOBAL LAND 1-KM PROGRAM AS SURROGATES OF CLIMATE DATA ON TEMPERATURE AND MOISTURE IN THE ENTIRE EASTERN AFRICA STUDY AREA. GLOBAL 1-KM DATA WILL BE USED TO EXTRAPOLATE AND ITERATIVELY FIT THE KNOWN DISTRIBUTION OF THE IMPORTANT* S. MANSONI-BIOMPHALARIA *AND* S. HAEMATOBIUM-BULINUS *SYSTEMS TO TMAX AND NDVI DATA (EXTRACTED FROM 5 KM DIAMETER AREAS CENTERED ON SURVEY SITES) TO ANNUAL, WET SEASON AND DRY SEASON COMPOSITE MAPS. MORE DETAILED DEKAD-BY-DEKAD ANALYSIS (36 PER YEAR) OF TMAX AND NDVI DATA WILL THEN BE DONE, AND COMPARED TO DAILY DATA FROM THE CLOSEST CLIMATE STATION AND 30-YEAR-AVERAGE CLIMATE DATA FOR THE RESPECTIVE DEKAD. RESULTS WILL BE EVALUATED IN RELATION TO AVAILABLE LABORATORY AND FIELD DATA ON THE ABIOTIC DEVELOPMENTAL REQUIREMENTS OF SNAIL HOSTS AND INTRAMOLLUSCAN STAGES OF* SCHISTOSOMA. *TMAX WILL REPRESENT THERMAL FACTORS THAT DRIVE SNAIL-PARASITE-DEVELOPMENT USING THE CUMULATIVE GROWING-DEGREE-DAY (GDD) CONCEPT.* S. MANSONI *REQUIRES AN ACCUMULATION OF 268 GDD ABOVE THE BASE OF 14.2 C° TO COMPLETE DEVELOPMENT;* S. HAEMATOBIUM *REQUIRES 295 GDD ABOVE THE BASE OF 15.3 C° (PFLUGER, 1981; PFLUGER ET AL., 1984). NDVI WILL BE USED TO REPRESENT THE CUMULATIVE EFFECTS OF MOISTURE AND THERMAL REGIME. QUERY AREAS WILL BE FIT TO SCHISTOSOME-SNAIL HOST DATA FOR BOTH TMAX AND NDVI*

SEPARATELY, AND FOR THE AREA WHERE BOTH CRITERIA ARE MET. A SPECIAL EFFORT WILL BE MADE TO VALIDATE REPORTS THAT THE DISTRIBUTION OF B. PFEIFFERI *IS LIMITED BY INABILITY TO REPRODUCE WHERE WATER TEMPERATURES EXCEED 27 C° FOR PROLONGED PERIODS (>179 GROWING DEGREE HOURS) DURING ITS MATURATION PERIOD (APPLETON, 1977; APPLETON AND ERIKSSON, 1984) AND TO DEFINE SIMILAR LIMITING FACTORS ON OTHER SYSTEMS.*

Global Land Use, Soil and Elevation Databases- Global land use, soils and elevation data layers, with associated linked databases in the ACT, will be incorporated in the regional GIS databases for Africa for analysis to identify and measure relationships of these factors to schistosomiasis risk.

Climate forecasts- It is proposed that climate forecasts using climate station databases and AVHRR-derived thermal-hydrology classes, modified by landcover class, soil, slope, aspect and catchment area analysis, can be used to predict long-term and annual suitability of different environmental zones for development and propagation of schistosomiasis. Climate suitability forecasts will be developed initially by use of climate databases available in the USAID Africa Country Almanac (Corbett et al., 2001), supplemented by data from the Crop Production Systems Zones of the IGAD Sub-region (Velthuisen and Verelst, 1995), the SADC RRSP database for East Africa (SADC, 1998) and the FAOCLIM (FAO, 1995) database. This will allow calculation of forecast indices based on potential evapotranspiration (PET) and water budget analysis according to the Thornthwaite +/or modified Penman-Montieth method. Using methods similar to that used for earlier work on *Fasciola* in east Africa (Malone and Yilma, 1998) monthly 30-year average data will be used to define long-term average or 'normal' forecast indices for each climate station. This analysis will serve to provide the distribution range and relative suitability of climate regime for the major schistosome-snail host systems that occur in each region.

Analysis will then be done, in collaboration with agro-climatologist JD Corbett, on *daily* climate archival records using MetWhere - part of the USAID Africa Country Almanac series, data from the internet sites of the National Climate Data Center (www.ncdc.noaa.gov) or NOAA Office of Global Programs (www.ogp.noaa.gov) for the same years in which Global 1-km AVHRR databases have been developed. The Climate Based Parasite Forecast System (Malone et al., 1987) will be used to define detailed patterns of climate and related development suitability indices for *S. mansoni* and *S. haematobium* and their snail hosts (Kristensen et al., 2001) where daily data is available. Results will provide climate suitability indices which will be statistically analyzed, with AVHRR-derived thermal-hydrology wetness value classes and other environmental variables extracted from the MMDb, for relationships to available data on distribution and abundance of *S. mansoni* and *S. haematobium* and their snail hosts. Analysis of archival daily climate records for additional years (available from the 1980's at most sites) will be done to define zones suitable for schistosomiasis transmission *each year* as compared to unstable zones where interannual variation in climate may lead to inconsistent propagation and transmission of schistosomiasis. Interpolated climate surfaces will be prepared from currently available annual *monthly* and annual *daily* climate records for east Africa (3 km resolution). The *daily* climate-based parasite forecast system software (Malone el al., 1987), originally written in Pascal, and the modified *monthly* data forecast system will be reprogrammed in Visual Basic for use with ACT software and databases.

ENVIRONMENTAL PREFERENCES AND LIMITS OF TOLERANCE FOR DIFFERENT SNAIL HOST SPECIES FOUND IN ENDEMIC AREAS – *SNAIL HOST SPECIES PREVIOUSLY DESCRIBED AS TO GEOGRAPHIC DISTRIBUTION WILL BE STUDIED TO DETERMINE RESPONSE TO DIFFERENT THERMAL-HYDROLOGICAL REGIMES ASSOCIATED WITH ADAPTATION TO THE ENVIRONMENT IN THEIR RESPECTIVE ZONES OF OCCURRENCE. DATA RECORDS WILL BE REVIEWED TO GEOLOCATE EACH RECORD REFERENCED TO: 1) QUARTER DEGREE GRID OF AFRICA AND/OR 2) POINT LOCATIONS OF SPECIFIC COLLECTION LOCATIONS WHERE SUCH INFORMATION IS DESCRIBED IN THE RECORD. THE LATTER WILL BE DONE BY REFERENCE TO HYDROLOGICAL, ROAD AND POPULATED PLACE FEATURES*

AVAILABLE IN THE GIS LAYERS FROM THE DIGITAL CHART OF THE WORLD (DCW) OR THE USAID AFRICA COUNTRY ALMANAC, SUPPLEMENTED BY REFERENCE TO THE GEONAMES GAZETTEER.

Objective 2: Create an operational 'Healthwhere' spatial decision support systems module for schistosomiasis epidemiological assessment and control program management by health workers in Africa, based on the USAID African Country Database series and associated software, available *Schistosoma*-snail host data, and a 'minimum medical GIS database' constructed as part of prior work in each region.

The Almanac Characterization Tool (ACT) represents a new generation of spatial decision support tools that provide decision-makers with an integrated packaged set of spatial databases and analytical tools. Although the ACT is a spatial information system, it does not replicate more complex or complete Geographical Information Systems. Instead, it aims to provide non-GIS specialists, particularly in the fields of agriculture and natural resource management, with an accessible and practical spatial information tool. A key concept behind the ACT is that it not only provides analytical tools, but, sets of foundation data. These data sets aim to represent the best available freely-distributable spatial data for a particular region. As an information tool, the ACT supports development investments and project planning, as well as, disaster mitigation.

JD CORBETT AND COLLEAGUES WILL FURTHER DEVELOP THE ACT FOR HEALTH APPLICATIONS, IN COLLABORATION WITH LSU, AS PART OF THE PROPOSED PROJECT. RESULTS DEVELOPED USING OTHER SOFTWARE (EG ARCVIEW, ERDAS) WILL BE USED TO PROGRAM THE ACT 'HEALTHWHERE' MODULE USING MANY OF THE SAME DATABASE RESOURCES AND FUNCTION FEATURES USED FOR PREDICTING ENVIRONMENTAL SUITABILITY ASSESSMENTS FOR CROPS. IN THIS SENSE, WE WILL DEVELOP APPLICATIONS THAT WILL ALLOW PREDICTION OF THE ANNUAL FLUKE AND SNAIL INTERMEDIATE HOST 'CROPS'. THIS WILL BE DONE STEPWISE TO DEFINE ENDEMIC ZONES USING LONG-TERM 30-YEAR AVERAGE DATA, INTERANNUAL RISK VARIATION IN ZONES USING WMO ANNUAL CLIMATE DATABASES, AND SCENARIO PREDICTIONS (EG. HYDROLOGICAL REGIME CHANGES, GLOBAL WARMING) AND DELIVERY OF A HEALTH APPLICATIONS MODULE TO USER AGENCIES. FOUNDATION DATABASES ARE CURRENTLY AVAILABLE AT THE AFRICAN CONTINENTAL SCALE, INCLUDING WMO DATA FOR THE ENTIRE CONTINENT, PLUS MORE COMPLETE INDIVIDUAL COUNTRY ALMANAC DATA FOR BOTSWANA, ETHIOPIA, KENYA, MALAWI, MOSAMBIQUE, TANZANIA, UGANDA, ZAMBIA, ZIMBABWE. OTHER COUNTRY DATA ARE AVAILABLE OR UNDER CONSTRUCTION FOR MALI, SIERRA LEONE, GHANA AND LIBERIA.

Objective 3. Design and begin to implement an operational system for regional health scientists to access and utilize spatial decision support systems for schistosomiasis epidemiological assessment and control program management.

To facilitate project collaboration, a workshop (3-4 day) will be held in east Africa at the initial phases of the project to enable project co-investigators to exchange data, to discuss results of model development in each area, and to provide for collaborative effort on application of new developments resulting from project work. A second workshop will be held in Summer, 2002 to provide instruction to health agency workers and researchers on use of the initial version of the 'HealthWhere' software module for schistosomiasis. Project results will be reported at the September, 2002 meeting in Johannesburg, South Africa.

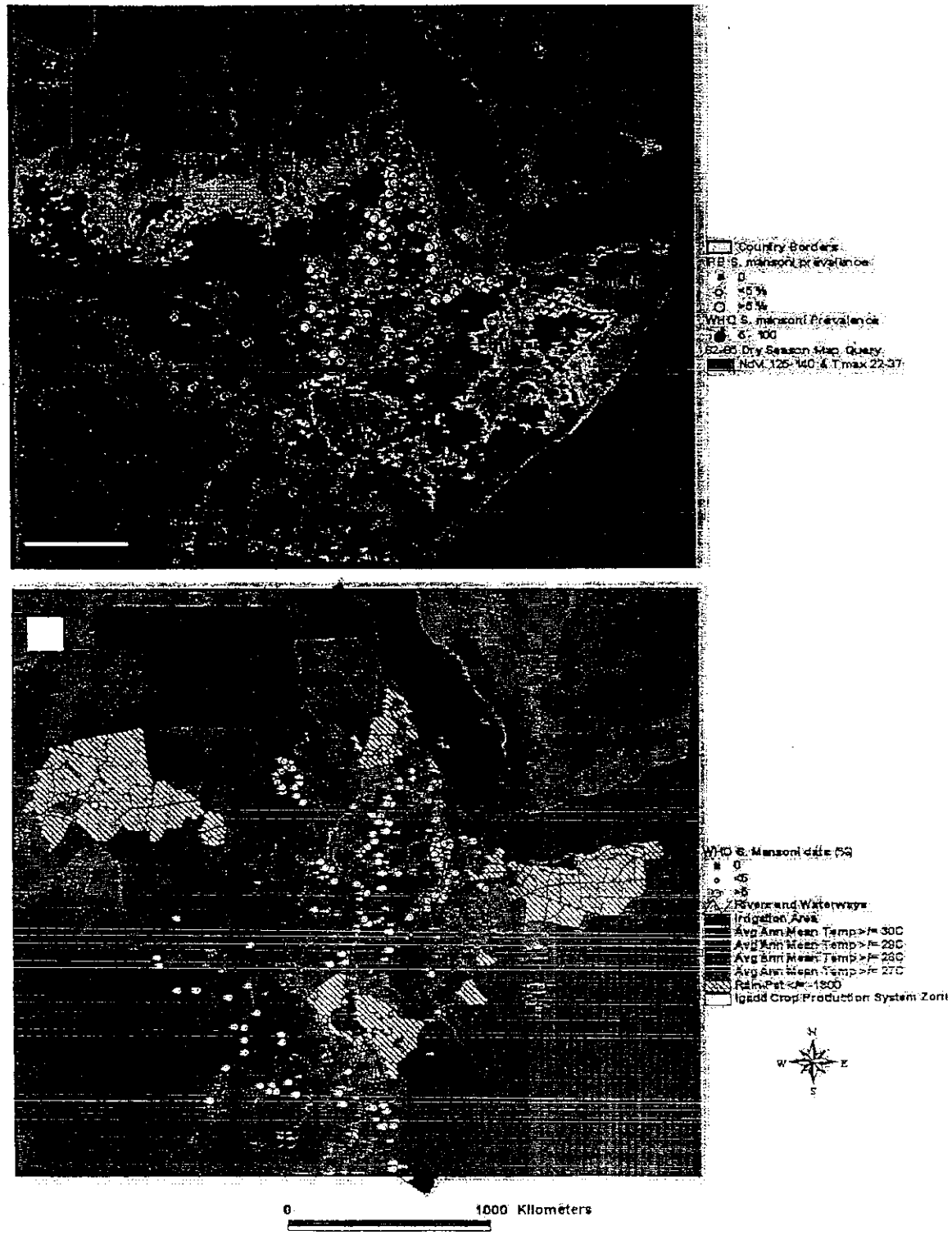
JD CORBETT WILL BE RESPONSIBLE FOR PROGRAMMING THE HEALTH MODULE, BASED IN PART ON RESULTS OF RESEARCH DONE AT LSU. FUNDS WILL BE USED TO SUPPORT ONE SENIOR VISUAL BASICS (VB) OBJECT-ORIENTED PROGRAMMER (ONE-MONTH EFFORT) WHO WILL SUPERVISE TWO JUNIOR PROGRAMMERS, ONE FOR THREE-MONTHS EFFORT AT TEMPLE TX AND ONE FOR ONE-MONTH

EFFORT AT LSU. THE LATTER PROGRAMMER WILL CONVERT AN EXISTING DAILY AND MONTHLY DATA VERSIONS OF THE 'CLIMATE-BASED PARASITE FORECAST SYSTEM' (MALONE ET AL. 1987) FROM PASCAL TO VB FOR USE IN THE HEALTH APPLICATIONS MODULE AND WILL MAINTAIN GOOD TECHNICAL COMMUNICATIONS WITH THE COLLABORATION TEAM IN TEMPLE, TX. IT IS ANTICIPATED THAT THE NEW SOFTWARE MODULE ON HEALTH APPLICATIONS WILL BE USED BY CONTROL PROGRAM OFFICERS; A RELATED DATABASE MOST SUITED TO USE WITH THE FULL COMPLEMENT OF ARCVIEW 8.1 CAPABILITIES WILL BE MADE AVAILABLE TO ADVANCED USERS AND RESEARCHERS

A Rockefeller sponsored Team Residency was held at the Bellagio Conference and Study Center, Italy from April10-14, 2000 to address the topic 'Health Maps: A global network for control of snail borne disease using satellite surveillance and geographic information systems' (Malone et al., 2001). The proposed project in Africa will build on the collaboration plan developed for a global network of scientists interested in use of geospatial databases for control of schistosomiasis and other snail borne diseases. An Internet site has been implemented (www.GnosisGIS.org) for sharing data, research results and other relevant information, and mutual assistance for participating scientists. As they are developed in the proposed project, GIS products, instructions on data access and processing, and relevant information will be made available via this Internet site for use by other investigators working on schistosomiasis research funded from other sources and to health agencies responsible for control of the disease. Other research groups will be invited to collaborate by contributing to database resource development and to access GIS resources already available for their area of interest. The working group will provide a vehicle that will facilitate success of the proposed research project, making results available for both research purposes and control program application in Africa.

Geospatial databases for the Upper Nile River Basin will be further developed based on existing data from earlier studies in Ethiopia (1R03-AI 42077-01), Egypt (R15-AI-28192 TMP), the MOH/USAID Schistosomiasis Research Project, No. 263-0140.2, and data from studies by ES Loker, G Mkoji and colleagues in Kenya (USAID Grant No. DPE-5542-G-SS-601800). In the future, databases for the SADC region will build on GIS-based studies done by S Mukaratirwa on Zimbabwe during a 1999 CIES Fulbright Senior Research Scholar stay at LSU, studies on Zimbabwe by TK Kristensen during LSU visiting scientist studies in 2000 and 2001, and retrospective incorporation of data from published reports of work in the region, including field data from extensive previous studies by CC Appleton. In addition, future efforts in west Africa will build (the West Africa-Upper Niger River zone) on work initiated during a one-month USAID training program for Dr Saidou Tembely of Mali, who will be responsible for development of that regional site at the University of Mali.

Figure 2


Country Borders
S. mansoni prevalence
0
<5%
>5%
WHO S. mansoni Prevalence
6 - 100
62-65 Dry Season Map Query
NDVI 125-140 & T max 22-37
WHO S. Mansoni data (%)
0
<5
>5
Rivers and Waterways
Irrigation Area
Avg Ann Mean Temp >/= 30C
Avg Ann Mean Temp >/= 29C
Avg Ann Mean Temp >/= 28C
Avg Ann Mean Temp >/= 27C
Rain Fst <= 1300
Igadd Crop Production System Zone
N
W
E
S
0
1000 Kilometers

251

Budget:

Budget Section 1: LSU
LSU Budget (@ 26% Off Campus Rate for Overhead)

		Requested Funds	LSU Cost Share*
Personnel			
John B Malone	10%		$8,328
Research assistant:	50%	$18,000	
Fringe Benefits (22%)		$3,960	$1,874
Local Travel		$2,500	
Supplies		$2,000	
Operating Services (Phone, FAX, FEDEX etc)		$1,000	
Total Direct Costs		$27,450	$10,202
Facilities & Adminstrative Costs (@26% off-campus rate)		$7,137	$2,653
Total Section 1: Project Costs to LSU		**$34,587**	**$12,855**

*No Cost to project for Dr Malone's salary

Budget Section 2: Regional partners and workshops (managed by Mud Springs Geographers, Inc.):

Design workshop (to take place immediately after contract initiation):
Venue KEMRI, Nairobi

Airfare: $1,400 times 2 persons from USA to Nairobi	$2800	
$700 times 2 persons Addis to Nairobi	$1400	
Hotel (3 nights, 4 persons = 12 room-nights)	$1200	
Per Diem (4 days, 4 persons = 16 days)	$800	
Miscellaneous costs (visas, supplies, etc.)	$500	
Total for design meeting:		$6,200

Regional Site SubContracts (local data collection and analysis)

Kenya Medical Research Institute	$4,000	
Total for Regional Site SubContracts:		*$4,000*

Model confirmation / HeathWhere module testing workshop (to take place July 2002): venue Nairobi

Airfare: $1,400 times 2 persons from USA to Nairobi	$2800	
$700 times 2 persons Addis to Nairobi	$1400	
Hotel (3 nights, 4 persons = 12 room-nights)	$1200	
Per Diem (4 days, 4 persons = 16 days)	$800	
Miscellaneous costs (visas, supplies, etc.)	$500	
Total for model confirmation / HealthWhere module testing meeting:		$6,200

Total Section 2: Regional partners and research and development workshops ***$16,400***

Budget Section 3: Mud Springs Geographers, Inc.

Personnel (workshops, HealthWhere module development)		
Administration / design / implementation (Corbett)		$12,000
Senior Programmer:	$12,000	
Programmer	$20,000	
Spatial Database technician	$10,000	
Fringe Benefits on labor (22.5%)	$12,150	
Local Travel	$2,500	
Computer laboratory fee	$6,000	
Total Direct Costs	$74,650	
Mud Springs Geographers, Inc. Indirect Costs (21%)	$15,676	
Total Section 3: Project Costs to Mud Springs Geographers, Inc.		**$90,326**

Grand Total ($34,587 + $16,400 + $90,326) $141,313

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LSU PROPOSAL # [illegible]

INTERNATIONAL FERTILIZER DEVELOPMENT CENTER • MUSCLE SHOALS, ALABAMA 35662 USA
P.O. BOX 2040 • 256-381-6600
EMAIL-general@IFDC.org
TELEFAX NO. 256-381-7408

Memorandum of Understanding

Between

International Fertilizer Development Center
PO Box 2040
Muscle Shoals, AL 35662, USA

And

Louisiana State University (LSU)
South Stadium Road
Baton Rouge, LA 70803, USA

October 1, 2001

IFDC INTERNATIONAL FERTILIZER DEVELOPMENT CENTER • MUSCLE SHOALS, ALABAMA 35662 USA
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Memorandum of Understanding

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And

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South Stadium Road
Baton Rouge, LA 70803, USA

The International Fertilizer Development Center (hereinafter referred to as IFDC) is a public international organization (PIO) dedicated to increasing sustainable agricultural production through the improved use of yield enhancing technologies. Louisiana State University (LSU) and Mud Springs Geographers have submitted a proposal to USAID to support development of global spatial models that can be used to predict the effects of environmental change on the risk of schistosomiasis and to guide disease control programs. In order to carryout the work described herein, IFDC hereby agree to the following terms and conditions:

1.0 INTRODUCTION AND STATEMENT OF WORK

The United States Agency for International Development (USAID) has entered into an Agreement with IFDC for IFDC to undertake a project entitled "Quick Start for Agriculture in Africa" to support the Geographic Information for Sustainable Development (GISD) project leading up to the World Summit on Sustainable Development (WSSD).

IFDC will provide USAID/EGAD/AFS with logistical and management support to the various partners involved in the implementation of the GISD project, including transferring and providing overall fiscal oversight to specific "pass-through" funds to selected partners who are

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being asked to implement specific GISD activities. This will include work already identified in specific proposals from the NRC, OGC, and several other groups located in the four Target Regions: Upper Niger Basin, African Great Lakes Region, the Kenya-Tanzania Coastal Zone, and the Limpopo/Zambeze River Basin Region of southern Africa.

IFDC will work in close collaboration with the technical officers within USAID providing oversight: Note: The Overall Coordinator is Robert E. Ford, AEMD – Agricultural Enterprise and Market Development Division within USAID's office of Agriculture and Food Security. Robert E. Ford is the Chair of the GISD-IWG for Regional Applications sub-group.

Close coordination must also occur with co-Chairs of the GISD-IWG for each sub-region. They are: Barbara Best (G/ENV) for the Kenya-Tanzania CZM Activity; Paul Bartel and Jon Anderson (AFR-SD) for the Four Corners/Limpopo/Zambezi Basin region; Robert Ford for the Great Lakes/Great Horn of Africa Region; and Mike McGahuey (USAID/AFR-SD).

Louisiana State University (LSU) and Mud Springs Geographers will (1) develop regional-scale geospatial methods to predict variation in risk of schistosomiasis associated with climate, water development and other environmental changes by matching the environmental preferences and limits of tolerance of Schistosoma parasite-snail host systems to the range of thermal-hydrology conditions found within the distribution range of the species found in the Lake Victoria Basin; (2) Create a "HealthWhere" spatial decision support systems module for schistosomiasis based on the ACT software, Schistosoma-snail host distribution data, and a "minimum medical GIS database" ; and (3) Enhance the capacity of scientists at the Kenya Medical Research Institute to develop, validate, and implement spatial decision support systems in national control programs for schistosomiasis. A description of the activities to be undertaken by LSU technical procedures to be followed, deliverables required, and estimated schedule are presented in Attachment 1, which is incorporated as an integral part of this Memorandum of Understanding (MOU).

2. SPECIFIC CONDITIONS

2.1 Effective Dates of MOU

The effective dates of this MOU are October 1, 2001-September 30, 2002.

2.2 Finance

The work to be performed under this MOU is being financed by USAID with all funds channeled to IFDC. IFDC shall provide funding to LSU in accordance with the terms and conditions described in this MOU. The estimated funds available to LSU total US $ 34,587 (thirty-four thousand, five hundred eighty-seven) as follows:

Item	Total US $
Personnel	
Research Assistant	18,000
Fringe Benefits	3,960
Local Travel	2,500
Misc. Supplies	1990
operating services	1000
Subtotal	**27,450**
Administration @ 26%	7,137
TOTAL	**34,587**

2.2.1 Use of Funds

IFDC has fiduciary responsibility of funds received from USAID. Under the terms of this MOU, all funds provided to LSU shall be utilized solely for the purposes indicated in the budget under 2.2. Said funds shall cover all expenditures necessary for the services to be performed by and or arranged by LSU. IFDC shall not be responsible for any additional costs (i.e., above US $34,587) incurred in the performance of the work described under this MOU.

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2.2.2 Allowable Costs

(a) LSU shall be reimbursed for costs incurred in carrying out the purposes of this MOU, which are reasonable, allocable, and allowable.

(b) Reasonable shall mean those costs that do not exceed those which would be incurred by an ordinarily prudent person in the conduct of normal business.

(c) Allocable shall mean those costs which are necessary to the MOU.

(d) Allowable shall mean those costs which are reasonable and allocable, and which conform to any limitations set forth in this MOU.

(e) Prior to incurring a questionable or unique cost, LSU is encouraged to obtain IFDC's written determination as to whether the cost will be allowable.

2.2.3 Payments

IFDC shall make payments to LSU based upon receipt of an official invoice from LSU. The invoice may be faxed to the official IFDC Business Contact indicated in 2.6.1. The payments shall be made on a monthly basis based upon LSU'S submission of invoices which substantiate costs incurred in the performance of this MOU.

2.2.4 Financial Reports

LSU shall provide to IFDC, within 20 days of the end of each month under this program, a financial report detailing funds expended under this MOU. The financial reports shall include accounting for all allowable costs incurred by LSU under the program in accordance with the line item budget amounts indicated in 2.2.

2.2.5 Audit

LSU shall maintain books, records, documents, and other evidence in accordance with LSU's usual accounting procedures to sufficiently substantiate charges to this MOU. IFDC and USAID reserve the right to examine and LSU agrees to make available all financial records and documents of LSU as related to this MOU. Any costs that are determined by either IFDC or USAID to be inconsistent with the terms and conditions of this MOU shall immediately be refunded to IFDC. LSU is subject to the audit guidelines and provisions of 22 CFR Section 226.26. In accordance with the provisions of OMB Circular A-133, LSU is obligated to comply with the requirements of OMB Circular A-133. LSU is required to have an audit in full compliance with the guidelines of OMB A-133 and agrees that a copy of the audit report will be submitted to IFDC's supervisor, Accounting Services, by LSU within thirty (30) days of completion of the audit. By the signing of this MOU, LSU states that they were informed of, understand, and agree to comply with the applicable compliance requirements.

2.2.6 Refunds

(a) If LSU earns interest on advances under this MOU prior to expending the funds for program purposes, LSU shall remit the interest to IFDC or deduct the same from subsequent invoices of planned monthly expenditures in accordance with 2.2.3.

(b) Funds not disbursed to LSU at the time the MOU expires or is terminated shall revert to IFDC, except for such funds encumbered by LSU by a legally binding transaction applicable to this MOU. Any funds advanced to but not expended by LSU at the time of expiration or termination of the MOU shall be refunded to IFDC except for such funds encumbered by LSU by a legally binding transaction applicable to this MOU.

(c) If, at any time during the life of the MOU, or as a result of final audit, it is determined that funds provided under this MOU have been expended for

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purposes not in accordance with the terms of this MOU, LSU shall refund such amount to IFDC.

2.3 Language

The MOU has been executed in English, which shall be the binding and controlling language for interpretation of the terms and conditions of this MOU.

2.4 Subagreements

It is understood that LSU may carryout the work described under this MOU in collaboration with others. It is further understood that funds provided to LSU may be used to support work carried out by collaborating institutions. LSU shall ensure that the specific conditions of this MOU (i.e., Section 2.0, Specific Conditions) shall apply to all such subagreements.

2.5 Revision of MOU Budget

(a) The approved MOU budget is the financial expression of LSU's program.

(b) LSU shall immediately request approval from IFDC when there is reason to believe that within the next 30 calendar days a revision of the approved MOU budget will be necessary for any of the following reasons:

- To change the scope or the objectives of the program and/or revise the funding allocated among objectives by more than ten percent of the total budget amount unless the schedule states otherwise.
- Additional funding is needed.
- LSU expects the amount of authorized funds to exceed its needs by more than $5,000 or five percent of the MOU budget, whichever is greater.

(c) Except as required by other provisions of this MOU specifically stated to be an exception from this provision, IFDC shall not be obligated to reimburse LSU for costs incurred in excess of the total amount obligated under the MOU. LSU shall not be obligated to continue performance under the MOU (including actions under the "Termination Procedures" provision) or otherwise

to incur costs in excess of the amount obligated under the MOU, unless and until IFDC has notified LSU in writing that such obligated amount has been increased and has specified the new MOU total amount.

2.6 Other Terms and Conditions

The following terms and conditions, which are applicable to the MOU by and between USAID and IFDC, shall be integral part of this Agreement.

2.6.1 Official Contacts

The contacts under this MOU for all official contacts are as follows:

IFDC Technical
Dr. Lawrence L. Hammond
Director, Research and Development Division
IFDC
PO Box 2040
Muscle Shoals, AL 35662, USA
Telephone: 256/381-6600, extension 270
FAX: 256/381-7408
lhammond@ifdc.org
www.ifdc.org

IFDC Business
Mr. John H. Allgood
Director, Finance, Administration, and Support Services
IFDC
PO Box 2040
Muscle Shoals, AL 35662, USA
Telephone: 256/381-6600, extension 211
FAX: 256/381-7408
jallgood@ifdc.org
www.ifdc.org

LSU Technical Contact
Dr. Jack Malone
DVM
Professor
Louisiana State University
School of Veterinary Medicine
South Stadium Road
Baton Rouge, LA 70803
Telephone: 225/578-9692
malone@mail.vetmed.lsu.edu

LSU Business Contact
James L. Bates
Director, Office of Sponsored Programs
LSU
330 Thomas Boyd Hall
Baton Rouge La. 70803
Telephone: 225-578-3386 ; Fax: 225-578-5403
E-Mail: osp@LSU.edu

2.6.2 Publications and Media Releases

If it is LSU's intention to identify USAID's contribution to any publication, video or other information/media product resulting from this MOU, LSU shall state that the views expressed by the author(s) do not necessarily reflect those of USAID. Acknowledgements should identify the sponsoring USAID Office and Bureau or Mission as well as USAID substantially as follows:

"This [publication, video or other information/media project (specific)] was made possible through support provided by the Center for Economic Growth and Agricultural Development, Office of Agriculture and Food Security, under the terms of the MOU. The opinions expressed herein are those of the author(s) and do not necessarily reflect the views of USAID."

LSU shall provide the relevant strategic objective or results package team with one copy of all published works developed under this MOU and with lists of other written work produced under the MOU.

Except as otherwise provided in the terms and conditions of the MOU, the author or LSU is free to copyright any books, publications, or other copyrightable materials developed in the course of or under this MOU, but USAID reserves a royalty-free nonexclusive and irrevocable right to reproduce, publish, or otherwise use, and to authorize others to use the work for U.S. Government purposes.

2.6.3 Reports and Data

LSU shall send to the IFDC Technical Contact at the address included in this MOU, monthly and quarterly progress reports in a form and substance satisfactory to IFDC. The monthly reports will provide a brief report on the status of activities being undertaken to implement this project during the previous 30 days.

The quarterly reports shall indicate progress toward achieving Program objectives and implementing approved work plans. The reports shall include, but not be limited to, the following information:

- Status of achievement of program goals, objectives, and benchmarks specified in the annual work plan
- Progress or completion of components, elements, or activities against planned targets
- Program description
- Other accomplishments or program highlights
- Identification and explanation of significant problems which have been encountered
- Description of planned corrective action

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The monthly and quarterly reports may be submitted in electronic format and are to be delivered to IFDC within 7 calendar days and 20 calendar days, respectively, of the end of the reporting period. A final report addressing the same components included in the quarterly report is to be submitted to IFDC by LSU within 45 calendar days of the ending date of this MOU. The reports submitted by LSU to IFDC and supporting materials compiled in performing the services shall be provided to USAID

The reports submitted by LSU to IFDC and supporting materials compiled in performing the services shall be provided to USAID.

2.6.4 Termination

This agreement may be terminated, in whole or in part, by either party at any time upon 30 days written notice of termination. Upon receipt of and in accordance with a termination notice from the IFDC, the LSU shall take immediate action to cease all expenditures financed by this MOU and to cancel all unliquidated obligations if possible. Further, upon receipt of notice of termination, the LSU shall not enter into any further obligations under this MOU. Except as provided below, no further reimbursement shall be made after the effective date of termination. The LSU shall within 30 days of the effective date of termination repay to IFDC all unexpended funds that are not otherwise obligated by a legally binding transaction applicable to this MOU. Should the funds paid by IFDC to the LSU prior to the effective date of termination be insufficient to cover the LSU's obligations in a legally binding transaction, the LSU may submit to IFDC within 90 days after the effective date of termination a written claim for such amount. The IFDC shall determine the amount(s) to be paid by IFDC to the LSU under such claim in accordance with the "Allowable Costs" provision of this MOU.

2.6.5 Dispute Settlement

Because of the nature of this agreement and legal status of the respective organizations engaged under this MOU, every attempt will be made to resolve all disputes through discussions/negotiations by and between the signatories to the MOU. Any controversy which cannot be satisfactorily resolved by the parties shall be adjudicated in a court of competent jurisdiction.

2.6.6 Investment Promotions

No funds or other support provided hereunder may be used in a program or activity reasonably likely to involve the relocation or expansion outside of the United States of an enterprise located in the United States if non-US production in such relocation or expansion replaces some or all of the production of, and reduces the number of employees at, said enterprise in the United States.

No funds or other support provided hereunder may be used in a program or activity the purpose of which is the establishment or development in a foreign country of any export processing zone or designated area where the labor, environmental, tax, tariff, and safety laws of the country would not apply, without the prior written approval of IFDC.

No funds or other support provided hereunder may be used in an activity which contributes to the violation of internationally recognized rights of workers in the recipient country including those in any designated zone or area in that country. This provision must be included in all subagreements.

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2.6.7 Non-Liability

IFDC does not assume liability for any third party claims for damages arising out of this MOU.

2.6.8 Notices

Any notice given by either party under this MOU shall be sufficient only if in writing and delivered in person or faxed or mailed postage prepaid to the official contact persons identified in 2.5.1

2.6.9 Special Provisions

LSU shall comply with USAID environmental regulations (22 CFR Section 216 "Regulation 16") with respect to the activities to be undertaken under this MOU.

2.6.10 Procurement Policies and Procedures

Because USAID is the sole contributor, USAID procurement policies and procedures are applicable (22 CFR Section 226 and ADS 308.5.7a).

2.6.11 Ineligible Countries

Activities under this agreement may only be carried out in countries that are eligible to receive assistance under the Foreign Assistance Act. LSU shall provide IFDC in advance a list of those countries where activities are planned under this MOU.

2.6.12 Entire MOU

Unless otherwise specified, this MOU embodies the entire understanding between IFDC and LSU for the services to be provided and any prior to contemporaneous representations, either oral or written, are hereby superseded. No amendments or changes to this MOU, including, without limitation, changes in the statement of work, total estimated cost, and period of performance, shall be effective unless made in writing and signed by authorized representatives of the parties.

FOR AND ON BEHALF OF IFDC

By: [signature]

Name: JOHN H. ALLGOOD

Title: BY DIRECTOR OF ADMINISTRATION

Date: 11/30/01

FOR AND ON BEHALF OF LSU

By: [signature]

Name: JAMES L. BATES

Title: [illegible]

Date: 1/10/02

WITNESS:

By: [signature]

Name: LAWRENCE HAMMOND

Title: Director, R+D Division

Date: 1/30/01

WITNESS:

By: [signature]

Name: Michelle Miller

Title: Coordinator

Date: 1/10/02

Attachment 1

Scope of Work – Louisiana State University

This collaborative project will be done jointly by LSU and MudSprings Geographers. Spatial decision support systems software for schistosomiasis will be developed and validated for the *Schistosoma*-snail host systems that occur in divergent environments in the Lake Victoria Basin of Kenya, Uganda and Rwanda in East Africa. If successful, this will provide the basis of further collaboration to extend results to similar systems and health applications in other parts of Africa and in South America. In general, LSU will be responsible for further development of previously reported and current research results, assisted by MudSprings. Conversely, Mudsprings, assisted by LSU, will be responsible for programming the HealthWhere module and organizing design and implementation workshops on use of this new module as part of the 'AWhere-ACT' resource software package.

Specifically, research at LSU will aim to accomplish the following:

- Further develop regional resource databases previously developed at LSU on *Schistosoma*-snail host systems, a 'minimum medical GIS database' and selected data from the USAID Africa Country Almanac series to create models suited for researchers and advanced users of the full complement of ArcGIS 8.1 ERDAS Imagine software. This will provide the basis for programming an operational 'HealthWhere' spatial decision support system on CDROM as part of the AWhere-ACT resource database/software applications package.
- Work with collaborators at KEMRI, Nairobi, to validate and further develop provisional regional GIS models by incorporation of locally available data, including: 1) national control program data and 'gray literature' reports on schistosomiasis, and 2) a 'snail host layer' using available in-house collections records, data provided by colleagues from other malacology collections, key reference books and literature reports.
- Develop prediction models for each parasite-snail host system independently.
- Use dekad-by-dekad analysis of NDVI-Tmax satellite data, with climate data from other sources, to develop a satellite climatology-based forecast system for schistosomiasis, including identification of short term life cycle-limiting seasonal high or low temperatures on the major schistosome-snail host systems that occur.
- Use regional databases to study and characterize the environment at existing water development projects where it is already known what snail-schistosome systems are established, then make model predictions of environmental suitability for schistosomiasis at proposed water development sites.
- Provide a vehicle for facilitating successful use of project research by making results available for both research purposes and control program application via the Rockefeller Foundation funded GnosisGIS working group (www.GnosisGIS.org).
- Collaborate with MudSprings to incorporate additional agroecological data from the Africa Country Database Series (ACT), including long term standard climate station

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Budget:

LSU Budget (@ 26% Off Campus Rate for Overhead)

	Requested Funds	LSU Cost Share*	
Personnel			
John B Malone 10%		$9355	
Research assistant 50%	$18,000		
Fringe Benefits (22%)	$3,960	$2058	
Local Travel	$2,500		
Supplies	$1,990		
Operating Services (Phone, FAX, FEDEX etc)	$1,000		
Total Direct Costs	$27,450	$11,413	
Facilities & Administrative Costs (@26% off-campus rate)	$7,137	$2,967	
Total Section 1: Project Costs to LSU	$34,587		**$14,380**

*No Cost to project for Dr Malone's salary

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GEOGRAPHIC INFORMATION FOR SUSTAINABLE DEVELOPMENT

Final Project Report – December, 2002
International Fertilizer Development Corporation
Louisiana State University

The objectives of the project award to **Louisiana State University (LSU) and Mud Springs Geographers** were to:

1. Develop regional-scale geospatial methods to predict variation in risk of schistosomiasis associated with climate, water development and other environmental changes by matching the environmental preferences and limits of tolerance of Schistosoma parasite-snail host systems to the range of thermal-hydrology conditions found within the distribution range of the species found in the Lake Victoria Basin;
2. Create a "HealthWhere" spatial decision support systems module for schistosomiasis based on the ACT software, Schistosoma-snail host distribution data, and a "minimum medical GIS database" (MMDb) ; and
3. Enhance the capacity of scientists at the Kenya Medical Research Institute (KEMRI) to develop, validate, and implement spatial decision support systems in national control programs for schistosomiasis.

Status and progress on achieving program goals, objectives and benchmarks specified in the annual work plan:

Objective 1: Develop regional-scale geospatial methods to predict variation in risk of schistosomiasis associated with climate, water development and other environmental changes by matching the environmental preferences and limits of tolerance of Schistosoma parasite-snail host systems to the range of thermal-hydrology conditions found within the distribution range of the species found in the Lake Victoria Basin.

Development was initiated on geospatial risk models using: 1) a regional resource databases and methods available in the 'minimum medical GIS database' (MMDb) previously developed at LSU on *Schistosoma*-snail host systems[1,2] and, 2) selected data from the USAID Africa Country Almanac series (ACT).[3] The LSU Climate Based Parasite Forecast System was adapted for use with the ACT interface by re-programming the model in Visual Basic from the existing Pascal format. The goals were to create models suited for researchers and advanced users of ArcView 3.x/ArcGIS 8.1 and ERDAS Imagine software. Results provided the basis for programming an ACT HealthWhere Module for general use by health workers less versed in geospatial methods. JC McCarroll (Research Associate III, 50% time), Kelsey McNally (Graduate Assistant) and JM Malone (Computer Analyst) assisted in this effort at LSU.

A design meeting was held at the International Centre of Insect Physiology and Ecology (ICIPE) in Nairobi, Kenya for project planning by 9 project collaborators from Kenya, Ethiopia, Mudsprings and LSU on February 4-5, 2002. Project objectives and background were reviewed, the product(s) deemed needed were discussed, and assigned workplans were developed. A detailed description appears in the minutes of the meeting (Atch 1).

Spatial Decision Support System Development:

Data: MMDb Environmental resource data were used to construct the initial GIS, including a 1992-95 AVHRR satellite sensor data time series (dekadal), FAO Soils and Crop Production Systems Zones, and parasitological data from WHO and the Institute of Pathobiology, Addis Ababa, Ethiopia. Mudsprings provided data from the ACT, notably, climate surface data (5x5km grid). Working with collaborators in Africa, additional datasets were incorporated in an ArcView GIS project to expand the scope of already available geospatial and WHO schistosomiasis prevalence data in the MMDb for Ethiopia, Sudan, Uganda and Kenya to encompass the African Great Lakes region, including WHO schistosomiasis prevalence records for Tanzania. Snail host survey data for 153 locations in Kenya provided by Loker et al.[4] were supplemented by current studies at 22 sites on *Biomphalaria* spp near Lake Victoria, mainly *B. sudanica*, from G Mkoji. Because it was more complete and systematic than available WHO *S. mansoni* infection prevalence data, snail survey data was the primary parasitological data used for initial model development. The working hypothesis was that sites where suitable snail hosts are found are potential foci for *S. mansoni*. Earlier work showed that separate risk models must be developed for the unique environmental niche of each major snail host-parasite system found in an area.[3] Use of snail hosts would allow separate distribution and risk prediction models to be developed for disparate environments of the two snail vectors of intestinal schistosomiasis in Kenya, *S. mansoni-B. pfeifferi* (mainly stream habitats) and *S. mansoni-B. sudanica* (Lake Victoria shoreline, other large lakes). Initial model development was limited to *S mansoni*. Development of similar models for the urinary schistosomiasis due to *S. haematobium* is in progress as part of the MS thesis research of K McNally at LSU.

Climate surface analysis: Analysis of ACT monthly 30-year-average climate surface grid data (5 x 5 km) covering the Lake Victoria region was a major focus of these studies. Monthly climate variables were extracted from the 153 grid cells in which *B. pfeifferi* was found. Fundamental climate data on mean temperature, rainfall (R), potential evapotranspiration (PET) and the R PET ratio was used to calculate monthly values for calculation of growing degree days (GDD=mean temperature > 14.2°C base for *S mansoni*), and values for candidate models. The 'potential generations per year' model was selected for further development (generations per year = GDD 263 if PET > 0.5; a cumulative total of 263 GDD needed for *S mansoni* to complete development in *B pfeifferi*.) Using suitability value ranges from known *B. pfeifferi* sites, a model based on accumulation of *S mansoni* growing degree days if soil moisture exceeds 50% saturation in the crop root zone (based on a 15 cm water column), was divided by 263 and extrapolated to the entire climate grid to produce a suitability map of the number of

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potential generations per year for *S. mansoni* in *B. pfeifferi* in Kenya (Figure 1). an upper thermal suitability threshold factor of >27°C for > 2 weeks (shown as masked area of unsuitable conditions). Literature reports indicate that reproductive capacity of B. pfeifferi snail vectors are sterilized in environments where monthly temperatures exceed 27°C for > 2 weeks.[15] These areas were masked (Figure 1-cross-hatched) within the GIS to eliminate unsuitable areas from consideration for *Schistosoma mansoni* transmission. The result was a map of climate-suitable areas that represented the distribution and relative risk of schistosomiasis associated with the *B. pfeifferi-S. mansoni* system in Kenya. Ninty-six percent of B. pfeifferi positive sites fell within the predicted distribution area with model values of >2 potential generations per year.

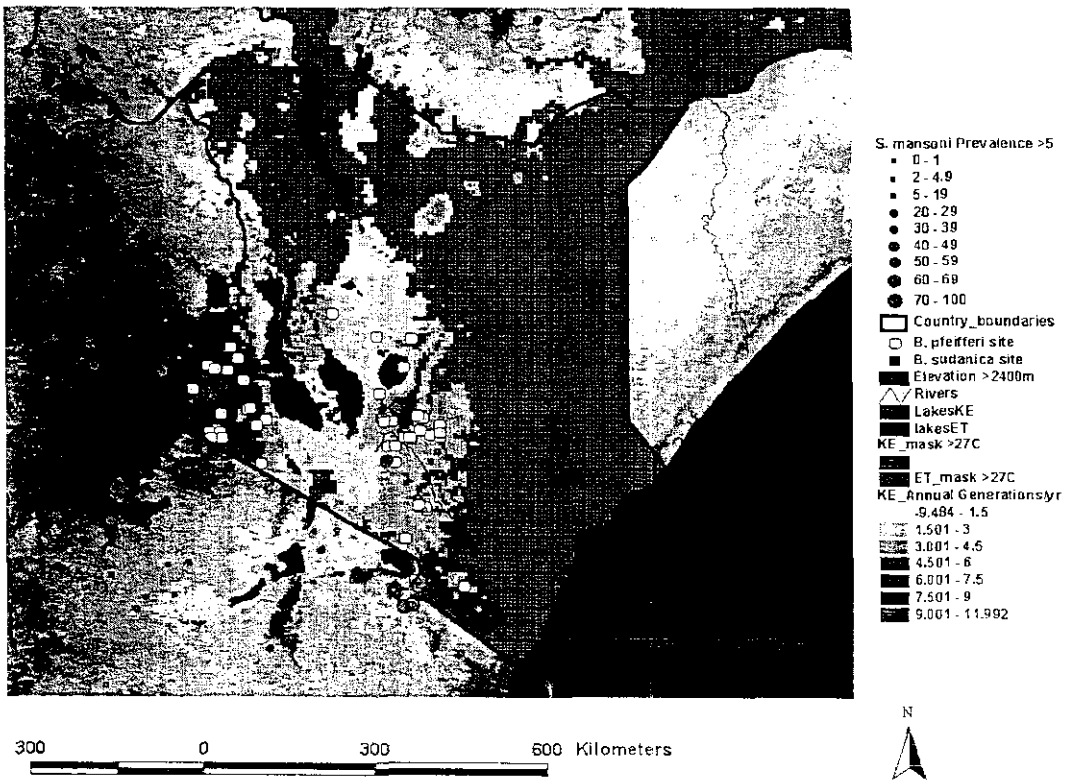

Figure 1. Model developed for Kenya showing predicted distribution and abundance of *S. mansoni* based on thermal-hydrological regime, the potential generations per year concept and an upper thermal suitability threshold factor of >27°C for > 2 weeks (shown as masked area of unsuitable conditions). The latter temperature regimes sterilize snail reproductive capacity.

The model developed using snail survey data for Kenya was then extrapolated on a provisional basis to a broader area of Ethiopia, Eritrea, Tanzania and Uganda (Figure 2) for validation against actual parasite prevalence data, *S. mansoni* survey data from the WHO and the Institute of Pathobiology in Ethiopia (*J Parasitol*, in preparation).

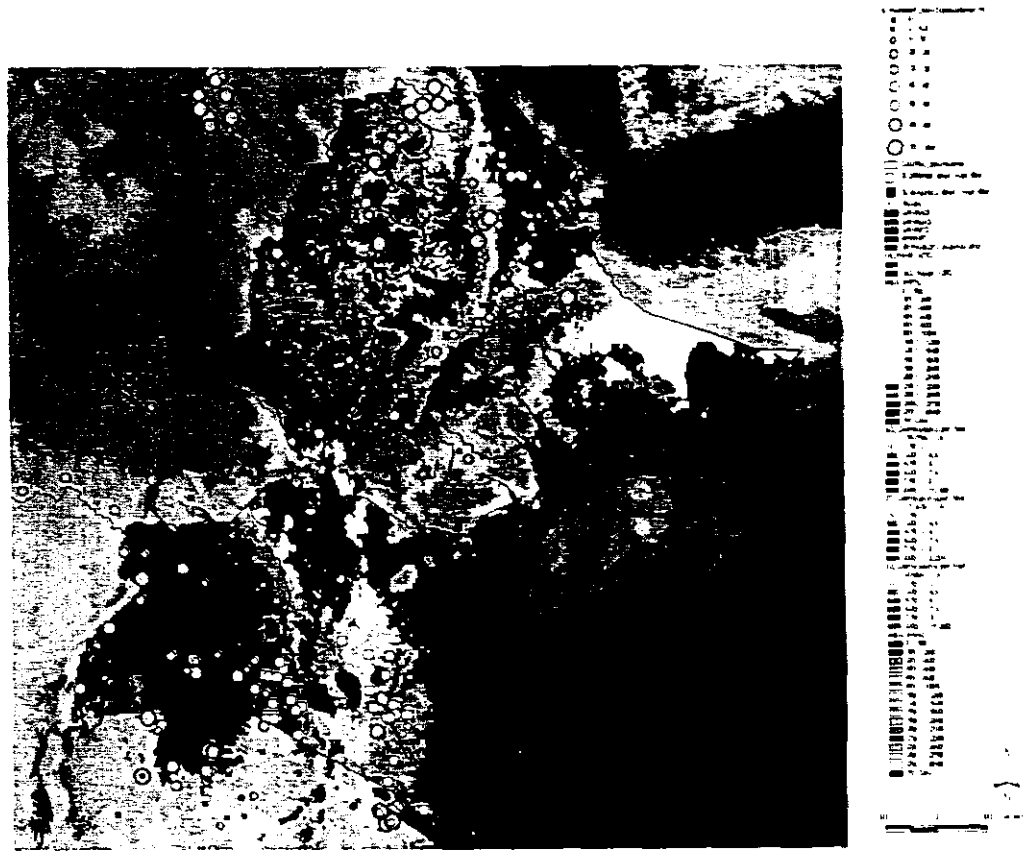

Figure 2. Extrapolation of the climate based model developed in Kenya to Ethiopia and Uganda showing the suitability of thermal-hydrological regime for propagation and transmission of the *S. mansoni-B. pfeifferi* system. Areas are masked where mean temperatures exceed the threshold of >27°C for >2 weeks. The model was validated against *S. mansoni* prevalence survey data from Ethiopia.

Preliminary statistical analysis of *S mansoni* prevalence data from Ethiopia,[7] the most complete independent database available, indicated a significant ($p<0.05$) association of prevalence >2% and potential generations per year. The major transmission period for *S mansoni* in Ethiopia occurs via human water contact during the several months (September to December) after the rainy season in a 'drying phase environment' as stable pools and eddies form that support snails, mainly along contracting, slower flowing waters of streams and rivers. The scatter diagram shown in Figure 3 suggests at least one complete *S mansoni* generation (snail infection to cercariae shedding) can be completed during this time interval. The diminishing prevalence rates at over 5 potential generations per year suggests a heat stress factor at higher temperatures on snail reproductive ability – for *S mansoni* development in snails. More detailed statistical analysis is in progress (*J Parasitol*, in preparation).

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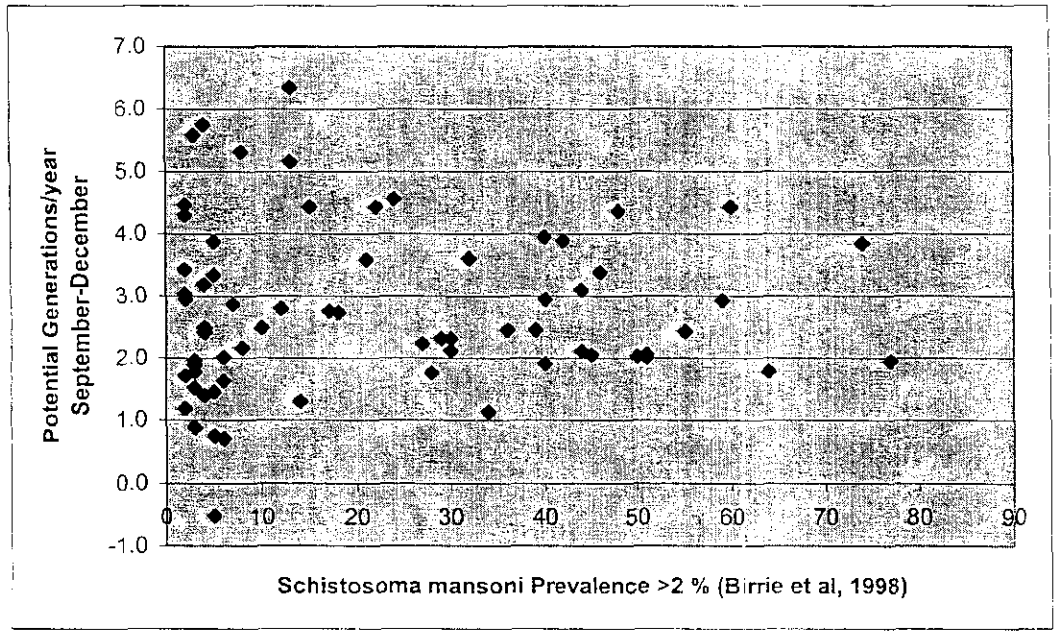

Figure 3. Scatter diagram showing potential generations per year in the dry season transmission period vs. recorded *S mansoni* prevalence >2% in Ethiopia.

AVHRR satellite data analysis: Previous satellite-based models developed for the IGAD/Nile Delta region.[3] were further developed to test use in Kenya as 'climate surrogate' data. Data extractions from Global 1-km AVHRR NDVI and land surface temperature (LST) annual, dry season and wet season composites (5 km buffers centered on survey points) from the MMDb were completed for the 52 known *B. pfeifferi* snail host sites for Kenya and WHO *S. mansoni* prevalence records for the IGAD region and Tanzania. Images from ERDAS Imagine were converted to grid files for analysis using the Spatial Analyst extension of ArcView 3.3. The model that best described (predictive value >95%) the known distribution of *S. mansoni* in the Lake Victoria Study Zone was based on dry season composite map data. Results of an ArcView query based on the model range of values from the 52 *B. pfeifferi* snail host sites in Kenya is shown in Figure 4 in comparison to WHO *S. mansoni* prevalence survey data sites.

Similar analysis of a dekad-by-dekad 1992-95 time series of NDVI-Tmax AVHRR satellite data was done for comparison with ACT climate surface analysis results. The aim was to develop satellite climatology-based forecast methods for schistosomiasis, including identification of short-term life cycle limiting seasonal high or low temperatures. Results indicated wide fluctuation of extracted values from 5km diameter buffers between dekads due to limitations of cloud-filtering methods used to obtain dekadal images free of the influence of clouds and atmospheric attenuation. AVHRR data analysis was therefore limited to annual and seasonal composite data; dekad-by-dekad analysis of the Global 1-km AVHRR dataset was delayed pending further processing of the data with an experimental data-smoothing algorithm by Dr Brad Reed of the EROS data center, Sioux Falls, SD.

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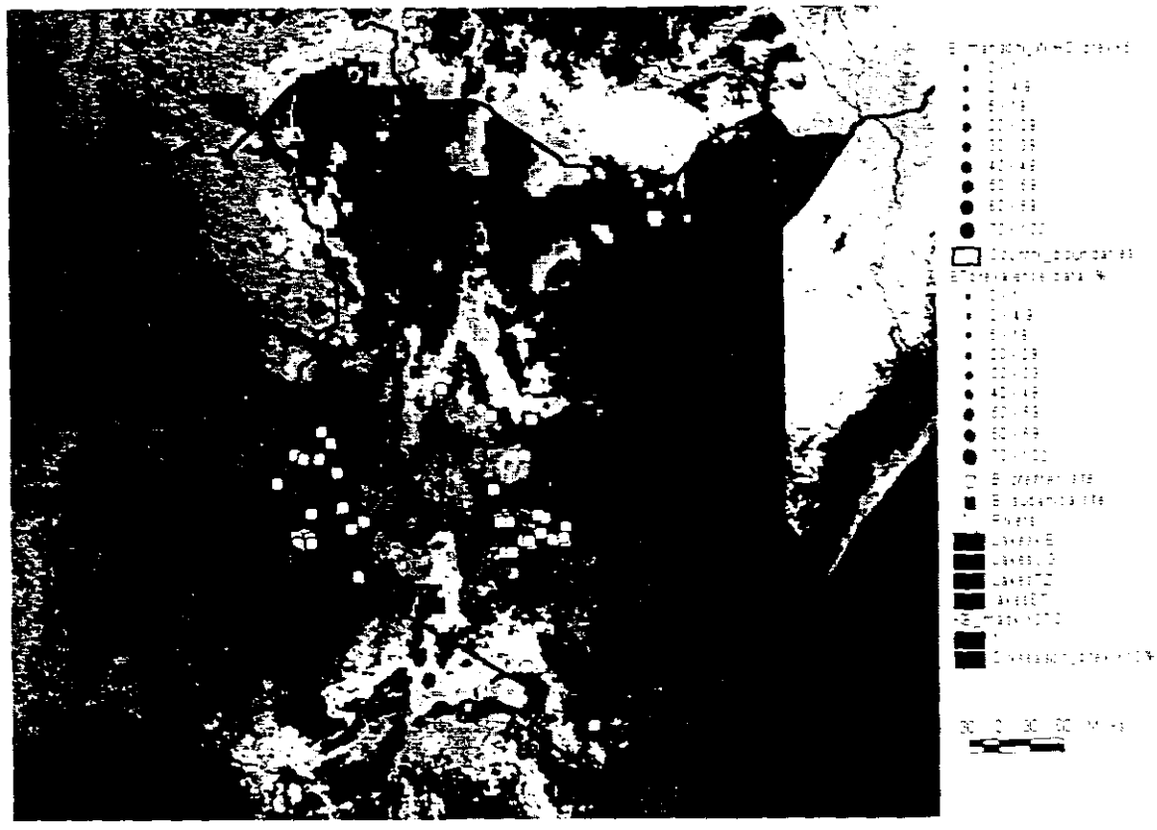

Figure 4. Vegetation index (NDVI) and Land Surface Temperature (LST) values from dry season Global 1-km AVHRR satellite sensor data were extracted from 5x5km buffers centered on known snail host sites. Mean values +/- 1 standard deviation for each were used to for a query (red) of areas where both NDVI and LST criteria were met. The query area depicts similar environments deemed suitable for the life cycle

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Objective 2: Create a "HealthWhere" spatial decision support systems module for schistosomiasis based on the ACT software, Schistosoma-snail host distribution data, and a "minimum medical GIS database" (MMDb).

Climate-Based Parasite Forecast System software, originally developed at LSU for *Fasciola* in cattle, was adapted for use in schistosomiasis risk assessment in Kenya. The forecast, based on GDD-water balance principles, uses daily climate records on rainfall and mean temperature to calculate a near real-time risk index of potential transmission severity in a given year. The software was re-programmed in Visual Basic computer language format from the original Pascal version to create a software module, 'HealthWhere', which is designed to interface with software analysis tools for

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agricultural crops available within the USAID Almanac Characterization Tool (ACT). This was accomplished via Mudsprings-LSU collaboration visits in Temple and telephone-email consultation sessions:

- LSU computer analyst JM Malone traveled to Temple, TX on May 11-13 to work with Mudsprings programmers on initial conversion of the LSU forecast from Pascal to VB. Subsequent telephone consultations with Jack Malone by David Hoelscher, Mudsprings programmer, were utilized to develop the provisional VB product.
- Jack Malone traveled to Temple, TX on 15-16 August 2002 in a collaboration visit to complete development of the Climate-based forecast and to develop its specific application to schistosomiasis in East Africa within the ACT environment.

MudSprings programmers in Temple, TX worked directly with Drs. John Corbett and Jack Malone to provide a potential evapotranspiration sub-model – a perquisite of the schistosomiasis model - designed to use the best available method for calculating PET dependent upon available input data. This flexibility is advantagous as the more accepted PET model (Penman Monteith) requires more input information than, for example, the Hargreaves equation. Provision of both methods, and the existing Thornthwaite method provided by LSU, improves future model utility. The Temple visit, facilitated by a conference call between David Hoelsher, Jack Malone, John Corbett and Stewart Collis, allowed a flexible 'growing degree day' model to be implemented in support of the schistosomiasis model within the ACT/HealthWhere interface. Growing degree-days serve as a useful measure of cumulative heat accumulation above critical species-specific thresholds of temperature and moisture.

Real-Time Forecast Modeling using HealthWhere Results of pilot studies done to assess potential risk of schistosomiasis in Kenya in a study area on the northeast shore of Lake Victoria is illustrated in Figure 5. Daily climate data values for the 1998-2001 period were linked to a climate surface grid array to generate forecast values based on simple rainfall and mean temperature data input. Selection of any grid cell in the array by 'point and click' generated model index output in graphical form, as shown in the lower right corner of Figure 5.

The long term aim, with further development of HealthWhere, is to program the forecast system, based on growing degree day-water balance principles, for use with climate data input from various sources, including daily climate surface data from NOAA satellite observations on Africa (eg. USAID FEWS data), or surfaces created from real time climate station observations from the NOAA 'globalsod' Internet data access site (ftp://ftp.ncdc.noaa.gov/pub/data/globalsod). The HealthWhere module is intended to be used as a flexible tool for climate analysis with 'settable' base temperatures, cumulative GDD requirements (generation time), upper and lower extreme climate thresholds and other values that determine the suitability of the environment for propagation and transmission of a variety of diseases. Initial application to schistosomiasis can be followed by development of similar models for other environmentally sensitive diseases,

such as Malaria, that impact health and development (Attachment 2). Ultimately, we envision that HealthWhere can be used in development of more comprehensive prediction models by integration of risk factors extracted from other types of data available in the MMDb ACT in grid format, including population, topography, soils, landuse and the rapidly evolving environmental modeling applications of new-generation earth observing satellite sensor data.[1]

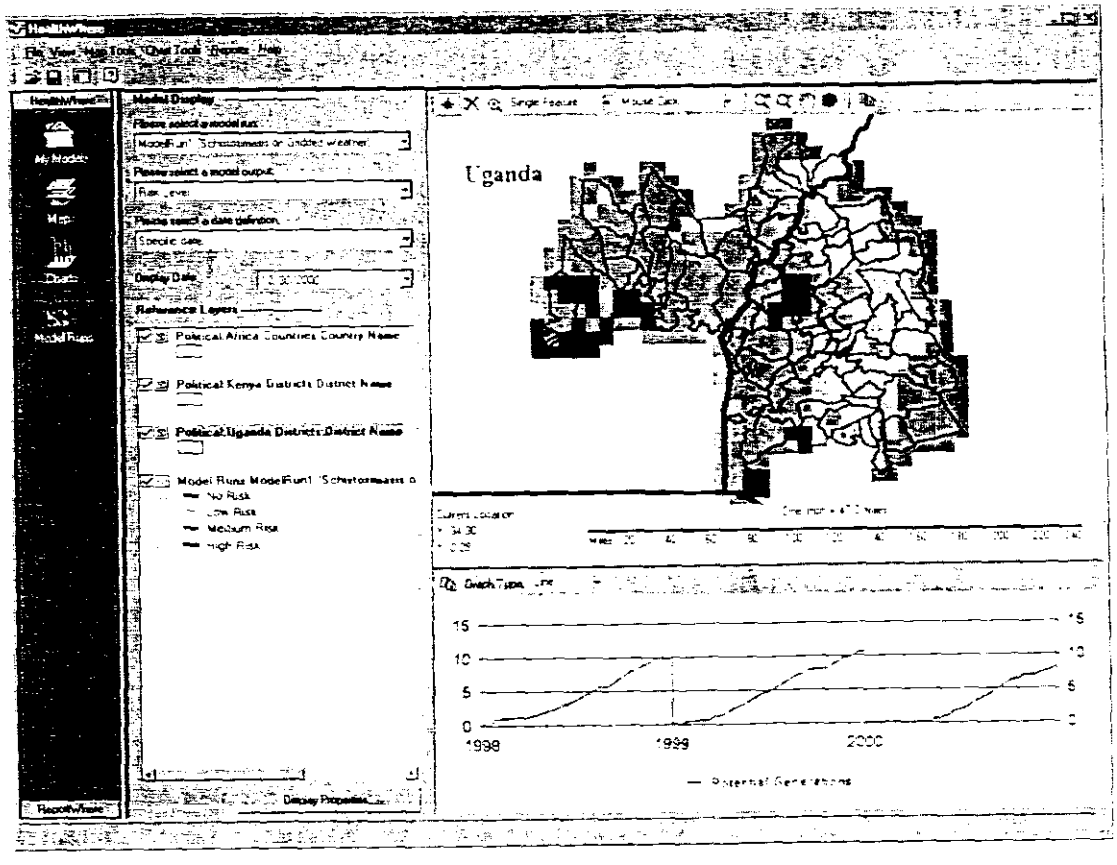

Figure 5. A 'HealthWhere' computer screen display illustrating results of pilot studies to interface ACT software with climate based forecast model software for real-time evaluation of potential schistosomiasis mansoni risk in a study area in Kenya along the northeast shore of Lake Victoria.

Objective 3: Enhance the capacity of scientists at the Kenya Medical Research Institute (KEMRI) to develop, validate, and implement spatial decision support systems in national control programs for schistosomiasis.

Dr Gerald Mkoji of KEMRI in Nairobi, the principal staff scientist responsible for advising the government on schistosomiasis control programs and research progress, attended both the project design meeting at ICIPE and the project implementation meeting at ILRI in Addis Ababa. He contributed information on the schistosomiasis

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problem in Kenya and current data on schistosomiasis, including new survey work on *B. sudanica* at Lake Victoria sites, to supplement published snail survey data used in project studies. He and his assistant began implementing a GIS capability for schistosomiasis at KEMRI in collaboration with Mudsprings-LSU and the malaria working group at KEMRI (R. Snow and others) who have implemented an advanced GIS and remote sensing capability primarily aimed at malaria control. Dr Mkoji was given a CDROM copy and instruction on use of the ACT by Benson Wafula after the design meeting. At the Implementation meeting, Dr Mkoji was provided with a portable computer equipped with AWhere, MetWhere software and the beta version of HealthWhere by Mudsprings. Dr Malone provided copies, at the implementation meeting, of the GnosisGIS.org Minimum Medical GIS Database (MMDb) CDROM, with documentation, to Drs G Mkoji, J Corbett and G Abebe for project use.

Other accomplishments and major highlights of program implementation:

- JB Malone attended the GISD project planning workshop in Washington DC on 29 August 2001 to present project plans to other GISD partners and project leaders.

- JB Malone attended the Africover meetings in Asmara, Eritrea, 3-6 April, 2002 to present progress to date on the project.

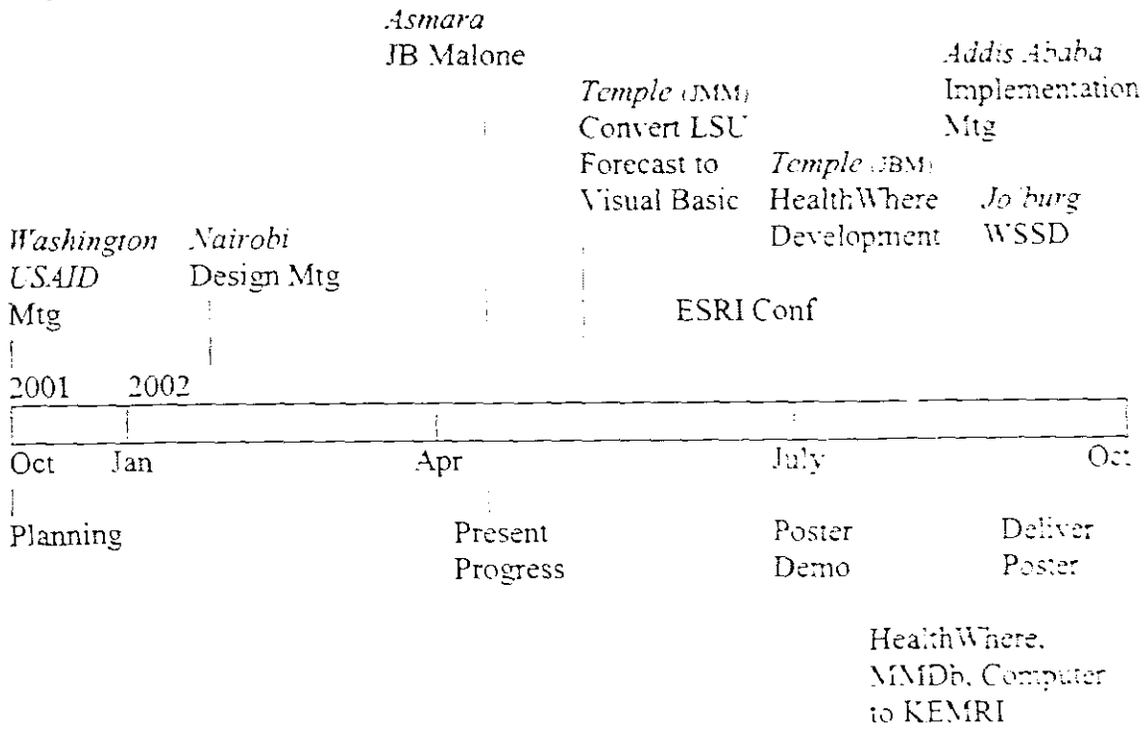
- A poster was created for WSSD and the ESRI user conference. This poster was designed to succinctly communicate project goals and background motivation. Laban MacOpiyo traveled from College Station, TX to Temple for briefing on the operation of the beta version HealthWhere module and the powerpoint presentation when he represented the project in Johannesburg.

- *UNMEE malaria model development.* At the Asmara Africover meeting in April, 2002, Dr Malone was approached by Capt.Ettore Poggi, Francisco Jose Iqualada, and Phillip Chinnici of the United Nations Mission to Ethiopia and Eritrea Joint GeoCell unit in Asmara with a request to do a pilot study for UNMEE on application of schistosomiasis risk assessment methods presented by Dr Malone to malaria. Malaria is an important operational concern of UNMEE forces and there was interest in demonstrating local goodwill by developing GIS applications that can be used for improved malaria control in to Eritrea and Ethiopia. Taking a similar approach as for schistosomiasis, the pilot studies generated promising results, reported to UNMEE in July, 2002, that were later followed up in Dr Malone's laboratory at LSU to further develop findings. The result was a publication 'A Climate-Based Risk Assessment System for Malaria in Eritrea' which has been submitted for publication to the American Journal of Tropical Medicine and Hygiene (Attachment 2). Because technician time, travel to Asmara and a country database-climate surface provided by Mudsprings were used in generating project results, the GISD project was credited for financial support in the acknowledgments. Similarly, the Eritrean Ministry of Health and the USAID Environmental Health Project (EHP) and were acknowledged for

providing epidemiological data to UNMEE on malaria and mosquito vectors and other data from a current USAID funded project in Eritrea used in the analysis. The article submitted is appended as Attachment 2.

- A second article on *S mansoni* model development to be submitted to the Journal of Parasitology and a third article on *S haemotobium* (MS project for Kelsey McNally of LSU) are currently in preparation.

Project Timeline:



Identification and explanation of significant problems or delays, corrective actions and major activities planned for future work.

- Delay in project initiation at LSU due to contract negotiations was corrected by assignment of both a ½ time associate and graduate student to the project through July.
- The project implementation meeting and software delivery plans for a meeting in Addis were changed from July to the last week of August. John Corbett and Jack Malone presented a special seminar to ILRI scientists and staff during the visit.
- Dr. Getachew Abebe agreed to represent our project in Johannesburg but later had to decline later due to other demands of his position as Dean at the Addis Ababa University Faculty of Veterinary Medicine. The HealthWhere project was represented at WSSD in September, 2002 by Laban MacOpiyo, who also represented the Livestock Early Warning System (LEWS) project. Laban was

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briefed on HealthWhere progress and the given an updated copy of the powerpoint presentation to be presented at WSSD during the August collaboration visit to Temple by JB Malone of LSU with Mudsprings staff. Mudsprings provided appropriate print materials and the 'Beta' HealthWhere program prior to Laban's travel to Johannesburg.

- A database issue emerged as the temperature data captured in the daily database has a very coarse grid (approximately 1 degree of longitude and latitude). This coarse grid will hide valuable local data and we are working to address the issue. Toward this resolution, a private US company, AWIS, was identified and found willing to contribute from their databanks all daily temperature and precipitation data for the east Africa region. The NOAA Globalsod Internet data access site (ftp://ftp.ncdc.noaa.gov/pub/data/globalsod) was identified as another source of near real-time climate data.

Agenda and Minutes: February 4 & 5, 2002 Design Meeting, ICIPE, Nairobi Kenya
Participants: John Corbett, Jack Malone, G Mkoji, Berhanu Erko, Getachew Abebe, Benson Wafula, Eric Muchuga, Laban MacOpiyo

Spatial Decision Support Systems and Control of Schistosomiasis in Africa

February 4, Monday

9:00 am – 9:30 am *Greeting and Welcome, Jack Malone and John Corbett*
Introduction to project: Jack Malone

John Corbett welcomed the group, all introduced themselves and the agenda was outlined.

Jack Malone reviewed progress (.ppt) to date on development of schistosomiasis models for East Africa and plans for future collaborative work to incorporate results in the ACT with Mudsprings. Regional disease risk models developed by earlier NIH and Rockefeller Foundation projects are available in ArcView GIS for *S mansoni* and *S haematobium* in the IGAD Nile Basin region as part of a minimum medical GIS database (MMDb). The latter consists of parasite snail host survey data and public domain data on the digital chart of the world, NOAA AVHRR Global 1-km satellite sensor data (NDVI and Tmax 10-day composites, 1992-95), USGS landuse, GTOPO30 elevation data, FAO soils, population political units health centers. The goal is to develop models for control program management and for predicting results of proposed water development projects in Africa (www.GnosisGIS.org). The benefits of linking this research effort and resulting MMDb to work on the ACT Africa country resource tool database led to the current project to develop a 'HealthWhere module' in the ACT AWhere 'user' environment.

9:30 am – 10:30 am *KEMRI: introduction to work on snail borne disease*
Ethiopia: work on same

Gerald Mkoji (KEMRI) reviewed results of earlier research in cooperation with ES Loker (U New Mexico) on biological control of schistosomiasis, focusing on earlier south Kenya snail surveys relating to potential biological control agents (eg. crayfish). He reviewed current related projects at KEMRI, including ongoing population dynamics studies on snail vectors, the KEMRI JICA Center for Training in Parasitic Diseases, and cooperative studies in Uganda and Tanzania in the Lake Victoria area. Discussion led to the conclusion that separate sub-models databases are needed for: 1) natural environments, 2) irrigation water development environments, and 3) each major parasite-snail host system. An earlier 1990's GIS effort is being continued to further develop snail ecology results by LSU KEMRI U New Mexico.

Berhanu Erko, Addis Ababa University, outlined current field studies on historical data and current NIH monthly snail-schistosome seasonal dynamics studies to monitor propagation and transmission in divergent Ethiopian environments. Potential primate (baboon) reservoir host data was cited as a current need.

10:30 am – 11:00 a. *Break*

11:00 am – 12:30 pm *John Corbett Brief of AWhere-ACT capability and strategic view of HealthWhere module*

John Corbett reviewed recent progress on AWhere development and new initiatives for its application in Africa, including the HealthWhere initiative, results of recent meeting on the

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Ethiopian Early Warning System (EWWS), the BASIS CRSP household survey database and activities of Mudsprings employees in Kenya. The new version of AWhere (v. 3.5), with a more complete climate module, is scheduled to become available in June, 2002. It was proposed that Benson Wafula develop a workshop on the ACT at KEMRI in the near future with G Mkoji, supported by Eric Muchugu and Laban MacOpiyo. Results of the EARO stakeholders meeting in January 28-30, 2002 in Addis, upcoming FAO-CIMMYT (Southeast Asia) meetings, wheat research programs in Bangladesh and Mexico and links to US universities were outlined. Cooperative development of heuristic models of disease using ACT and the MMDb was proposed.

12:30 p.m. – 1:30 p.m. *Lunch*

1:30 p.m. – 3:00 p.m. *Identification of 'wish list' for automation of tasks – the need*

Water development projects in Kenya were discussed by Gerald Mkoji, including existing and planned large-scale hydroelectric projects and the more numerous small dam/irrigation developments that pose the major risk of schistosomiasis transmission. At least one field trip by KEMRI to assess ground truth of models was suggested. Discussion led to identification of multiple autocorrelated factors (eg. rain, Max temp, GDD) in the outlook for model development. The clinical/societal effects of schistosomiasis were outlined by Berhanu Erko, Gerald Mkoji and JB Malone.

Discussion of 'who will use the tool' led to the conclusion that KEMRI in Kenya and the Institute of Pathobiology (IPB) in Ethiopia are responsible for advising the government on schistosomiasis control and that any model development and outputs (via hardcopy) would be through these research centers for Ministry of Health response at the district level. Praziquantel treatment for schistosomiasis is not routinely available via government sponsored primary care or organized surveillance-control programs in either Kenya or Ethiopia. The need to identify endemic risk, seasonality and susceptible populations in divergent areas to promote appropriate 'real time' diagnosis and treatment was emphasized via better reporting systems and decision support by hard copy model output from the medical research centers. Ideally, the output of models would assess 'where, when, how bad'.

Gerald Mkoji will organize a one-day public workshop at KEMRI at the time of the June project implementation meeting for public health specialists in area universities, research centers and NGO's. Further work development for the project will occur the second day. Before then, Gerald will train on the ACT with Benson Wafula and will be provided a portable computer with ACT within the next month. Potential avenues for model use and forecast outputs may be via a new partnership of KEMRI with the Department of Education, a KEMRI/JICA training facility for graduate students in public health and infectious diseases, and the Drought Outlook Center.

3:00 p.m.– 3:30 p.m. *Break*

3:30 p.m. – 5:00 p.m. *Further refinement of wish list, prioritization of wish list*
Introduction to possible programming solutions

Data from earlier NIH studies in Ethiopia and the IGAD/Nile Basin from the MMDb will be made available for programming development. Results of current research will be provided when completed. Additional more recent survey and literature data will be provided from KEMRI to supplement earlier Kenya schistosomiasis and snail host survey data (eg. Loker et al, 1992). Point locations of health systems (centers, hospitals and clinics) in each of the countries in the region

are needed using UN databases (EWA) and available Ministry of Health records. G Mkoji will obtain complete records published for Kenya by the Ministry of Health. Less complete health care site records for Ethiopia (in the ACT) and Somalia (from Eric Muchugu) are available. Published data on seasonal infection dynamics over time from past and current studies in Ethiopia (Erko) and Kenya (Mkoji) are needed.

Potential project products were assessed, including the value of:

- Long term spatial and temporal suitability models to advise districts on appropriate control
- Sequelae of water resources development; most Kenya risk is associated with small dams
- Short term forecasts (eg El Nino years): this may be not as important as for other diseases
- WHO recommended 'Rapid Epidemiologic Assessment' survey sampling plans can be facilitated by GIS to allow real-time surveillance and action
- Adaptation of an LSU climate based parasite forecast model for use with the MMDb research database and, after programming, in the ACT HealthWhere module.

February 5, Tuesday
9:00 am – 12:00 am Refinement of programmable solutions. Work plan outline. Assign tasks

Data currently available for model development was discussed and the goal was set of providing a 'master' database of currently available data for model development within 6 weeks. It was emphasized that the focus would be on use of *already available* data needed to meet project objectives of developing a schistosomiasis risk model covering the African Great Lakes area, programming this for use within the initial HealthWhere module, and establishing a medical GIS capability on snail-borne disease at KEMRI. The common database will include (responsible individuals are in parentheses):

1. The WHO Schistosomiasis Atlas data for the Greater Horn of Africa region in the MMDb (Ethiopia, Eritrea, Sudan, Kenya, Uganda, Tanzania), plus additional Ethiopia and South Kenya snail survey data being used for model development at LSU. The WHO Atlas covers up to the early 1990's (JB Malone). Additional data from the 1990's literature and informal records on schistosomiasis and snail hosts in Kenya will be sought by G Mkoji, who provided recent snail survey data for the Lake Victoria region at the meeting (G Mkoji).
2. Current new work at Texas A&M (Jerry Stuth) is being done (LEWS) on use of a 4-year daily weather database derived from daily NOAA satellite observations of Africa. The LSU Climate Based Parasite Forecast System will be programmed for use with this satellite-derived climate database (potentially available in real time) and climate surface grids by JM Malone and Mudsprings programmers in March-April, 2002. (John Corbett)
3. Annual and seasonal composite maps of Tmax and NDVI from the AVHRR Global 1-km are available in the MMDb. Time-series analysis of AVHRR dekadal data vs schistosomiasis risk is in progress at LSU. (Jack Malone)
4. The next version of AWhere 3.5, which is scheduled to be available in early June-July, 2002. (John Corbett)
5. Synoptic climate station data and long term 70-year climate data records will be sought by (Benson Wafula)
6. Local origin paper maps of Kenya (1984; 1:500,000) will be scanned and georeferenced for use (Eric Muchuga). Encarta software, to be provided with the KEMRI computer, has acceptable accuracy for geolocating survey sites where GPS coordinates or accurate maps are not available.

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7. The value of current Landsat ETM+ as more current surrogate basemaps was discussed. The budget includes funds for one scene ($600) to be processed and analyzed at LSU, in cooperation with G Mkoji, that covers high-endemic schistosomiasis area(s) of Kenya. Other Landsat data, other imagery data available at no or minimal cost will be sought (Jack Malone and G Mkoji).
8. Additional data on current work on snail population dynamics/seasonality from field studies on schistosome-snail host systems will be compiled by B Erko and G Mkoji for Ethiopia and Kenya, respectively (B Erko and G Mkoji).

12:30 p.m. – 1:30 p.m. *Lunch*

1:30 pm – 3:00 pm *Meeting wrap-up and conclusions. Possible future directions.*

GIS capability needed by project collaborators was discussed. The ACT will be provided to G Mkoji, Berhanu Erko, Getachew Abebe, and Ibrahim at EARO. There has been difficulty in the past in some cases of providing ArcView Software to Ethiopian collaborators because of high cost non-educational prices asked by local ESRI dealers. JB Malone and JD Corbett will contact ESRI to request educational group rate for software and upgrades (ArcView and Spatial Analyst +/or ArcGIS 8.0) from ESRI USA for project collaborators. The value of a working group List-Serve and/or web pages within the existing MudSprings.com and GnosisGIS.org sites was discussed and deemed desirable for group communication purposes.

The immediate products for the project will include development of a GIS model/case study for schistosomiasis in the African Great Lakes region that can be presented at the WSSD. Longer term, the aim is development of models for schistosomiasis and other diseases (such as Dr Getachew's Trypanosomiasis model) that can be used for a broader area of East Africa/Horn of Africa; these would operate both in the ACT as a HealthWhere applications module, and also within ArcView/ArcGIS as a 'research version'. If successful, we anticipate preparing applications for continued funding of HealthWhere applications and research products on a broader range of diseases from USAID and/or other agencies (NIH, Rockefeller etc), if possible by mutually leveraged funding.

The HealthWhere module is anticipated to be provided to medical and veterinary health workers as a separate CDROM(s) linked to ACT tools, minus un-needed aspects such as crop models and databases. The value of an ArcView/ArcGIS version of models and databases for advanced investigators was cited. Authorship and credits will include all who are in the current working group according to relative contribution.

3:00 p.m *Adjourn*

JBM 3/15/02

December 31, 2002

James W. Kazura, Editor
The American Journal of Tropical
Medicine and Hygiene
School of Medicine, W137
Case Western Reserve University
10900 Euclid Avenue
Cleveland, OH 44106-4983

Dear Dr Kazura,

The attached article entited 'A CLIMATE-BASED RISK ASSESSMENT MODEL FOR MALARIA IN ERITREA' is submitted for consideration for publication in the American Journal of Tropical Medicine and Hygiene. We believe results reported will be of interest to AJTMH readers by contribution of a new climate-based approach as part of current efforts to develop effective risk assessment systems for use in malaria control programs in Africa. The authors below have participated in and concur with this submission and subsequent revisions submitted by the corresponding author. The material has not and will not be considered for publication elsewhere.

Key words: Malaria, Eritrea, Climate, risk assessment, Models, *Plasmodium falciparum*, *Anopheles arabiensis*.

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A CLIMATE-BASED RISK ASSESSMENT MODEL FOR MALARIA IN ERITREA

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Abstract. Agroclimatic data and growing degree day-water balance spatial analysis were used to describe potential risk of malaria based on climate suitability for the *Plasmodium falciparum-Anopheles arabiensis* (Patton) system in Eritrea. A model based on monthly accumulation of the *product* of two climate gradients, growing degree days (mean temperature-16°C base temperature) and the ratio of monthly rain potential evapotranspiration (R/PET) was most significantly correlated with infection prevalence data from a 2000-2001 survey of malaria at 173 sites in Eritrea. Results indicate: 1) optimum conditions for malaria transmission occurs at sites with moderate temperatures (20-30°C) and 6-11 potential malaria generations per year during months in which soil moisture exceeds a threshold of 20% of holding capacity, 2) additional consideration of a hydrologic gradient (R/PET), with thermal factors, most accurately reflected field malaria risk, 3) there is a need to systematically account for heat stress at high temperatures that result in decreasing suitability for propagation and transmission of malaria, and 4) marked differences in seasonality of transmission pattern found in Eritrea can be predicted, using growing degree day-water balance models. As a regional-scale component of more comprehensive risk assessment methods, the climate-based models developed may enable future near real-time disease prediction and intervention by health system managers.

INTRODUCTION

Recent studies in Africa[1-7] have indicated the potential utility of operational spatial decision support systems for malaria risk assessment and control using geographic

information systems (GIS), climatology and remote sensing. Craig and others [8] developed continent-wide maps for Africa of stable and unstable malaria risk based on the effect of long-term normal rainfall and temperature values on key biological features that determine the geographic distribution of malaria. These maps, which have been widely distributed, were described as 'first level' results representative of average year continental risk levels that should be further developed: 1) at a sub-continental scale, taking into account inter-annual changes in climate and differences between major ecological zones, 2) at the national or regional scale, to further define transmission intensity and seasonality within a given country or region, and 3) at local scales, below the second administrative unit, to define variation in transmission in very localized areas, such as between villages.

The current work was aimed at national-scale development of a risk model for malaria in Eritrea based on regional GIS resource databases, including a 'minimum medical GIS database' (MMDb) for the IGAD/Nile Basin region[9] and a long-term normal climate surface from the United States Agency for International Development (USAID) Almanac Characterization Tool (ACT).[10] The continental first-level model of Craig and others was derived by a statistical algorithm which produced mapped zones of no malaria, unstable zones prone to epidemics and stable, endemic transmission zones. The stable transmission category provided no evaluation of relative suitability within stable endemic areas, however, and the model was based on simple inputs of rainfall estimates and mean temperatures. We focus here on potential use for malaria risk assessment by factors routinely used for crop suitability models, the growing degree-day (GDD) concept and

water balance analysis[11]. These methods been used to characterize the environmental effects of rainfall on the extent of potential snail habitats and transmission by defining water budget variables, including soil moisture content and surplus water, for *Fasciola hepatica* in the United States[12] and for schistosomiasis and fascioliasis[13-15] in East Africa.

In Eritrea, malaria accounts for over 30% of outpatient morbidity and 28% of hospital admissions. Two thirds of the population (3.5 million) lives in malaria endemic zones, with 15 % residing in urban areas and 85% in rural areas. An enormous topographical and ecological diversity occurs in Eritrea, a nation that borders on the Red Sea between Ethiopia, Sudan and Djibouti (Figure 1). Rainfall is scanty and highly seasonal, ranging from 400-650mm annually in the highlands to 200-300mm in the lowlands. There are three distinct malaria zones: 1) the western lowlands, elevation 500-1500 m above sea level, is considered endemic, 2) the coastal plains (0-1000 m above sea level), an arid area that is prone to sporadic epidemics, and 3) the highlands (1500-2000 m above sea level), an area that is generally free from malaria, but prone to malaria epidemics due to low population immunity. There was a malaria epidemic throughout the country in 1998. There are two main malaria transmission seasons relating to rainfall patterns, one between September and November in the central highlands and western lowlands and one between January and March in the coastal plains region. Most malaria cases (>90%) are due to *P. falciparum*. *P. vivax*, which tends to be localized in more restricted zones, accounts for <10% of infections, usually in areas where both species occur.[16]

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The specific objectives of the current study were: 1) to develop an environmental risk model for malaria in Eritrea, within a GIS, based on data from a 30-year-average monthly climate surface grid (5x5 km cells), growing degree day-water budget principles, and current knowledge of malaria epidemiology and environmental risk factors, and 2) to validate and modify the provisional regional-scale model using available malaria prevalence survey data from the United Nations Mission to Ethiopia and Eritrea (UNMEE) and the Eritrean Ministry of Health (MOH).

MATERIALS AND METHODS

Climate Surface Analysis. The MMDb and a climate surface grid with monthly long-term normal climate data were used to create derivative variables for a 'growing degree day-water balance' model and to define a suitability gradient in the environment for the *Plasmodium falciparum-Anopheles arabiensis* life cycle. Growing-degree-days (GDD) were accumulated for months in which conditions exceeded the threshold of >16°C base temperature[7], and a variable level of soil water holding capacity in the crop root zone. The latter was defined as conditions where the ratio of rain/potential evapotranspiration (R/PET) was >0.2, >0.5 or >1.0, indicating, respectively, that soil moisture was 20% or 50% saturated or that surplus water (and water runoff) was present. Soil moisture content was based on percent fill of a 15 cm rainfall-equivalent water column. Derivative climate variables, calculated for each cell of the 5x5 km climate grid, included monthly and annual values for cumulative GDD (mean temperature – 16°C) based on each of the three moisture threshold ratios. For the R/PET>0.2 threshold, values were calculated for the

months of April-October (highland rain season pattern) and November-March (coastal rain season pattern). For sites of overlapping pattern where R PET >0.2 was observed in both seasons, accumulated monthly GDD from both seasons were summed. A fourth factor, the *product* of GDD x R PET, was also calculated for analysis. These variables were calculated for comparison to parasitological data:

1) Sum of monthly GDD x days in month, conditional on soil water holding capacity of over 50% (R PET>0.5)
2) Sum of monthly GDD x days in month, conditional on a soil water holding capacity of over 20% (R PET>0.2)
3) Sum of monthly GDD x days in month, when monthly surplus water, and runoff water, is present (R PET>1.0)
4) Product of GDD x R PET, to create a continuous gradient of the above variables

Potential malaria generations per year were calculated for each of the three soil moisture thresholds (annual sum GDD >0.2, GDD >0.5 or GDD >1.0) and divided by 116, the value in cumulative GDD required to complete *Plasmodium falciparum* development in *An arabiensis*[7].

Data provided by the Eritrean MOH for analysis included a 2000-2001 controlled survey at 173 sites on malaria prevalence (points), with ancillary data on adult and larvae mosquito abundance.[16,17] This dataset, from a total of 13,279 individuals using a rapid

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diagnostic test kit[a] was the primary parasitological reference data used for model development. Candidate model thresholds were compared to the distribution of known malaria transmission sites from this survey. Provisional model output maps were created using ArcView 3.2 GIS software[b] with the Spatial Analyst extension.

Statistical analysis. Statistical analysis of the model by the Spearman correlation coefficient was done to identify significant relationships ($p<0.05$) of each of the candidate GDD-water balance models in comparison to survey percent prevalence, including altitude, total GDD, potential malaria generations per year at the >02, >0.5 and >1.0 R/PET thresholds, and the product of GDD x R/PET.

RESULTS

Of the three soil moisture threshold levels tested (R/PET >0.2, >0.5 or >1.0), the most significant correlation with prevalence survey data was obtained by the model based on accumulation of GDD (>16°C), if the crop root zone contained >20% of water holding capacity (R/PET>0.2). Maps produced using the soil moisture threshold of R/PET >0.5 described relative risk transmission zones in the highlands, but missed prediction of important known transmission sites in the drier coastal zone when compared to point data on percent prevalence values from a 2000-2001 survey at 173 sites in Eritrea. The 'surplus water' (R/PET>1.0) threshold produced a map of an even smaller area that included only the higher rainfall region in the southwestern part of the country and was inconsistent with actual distribution of malaria. Both the coastal (November-March rain

season) and highland pattern (April-October rain season) sites were included in the model after the soil moisture threshold was adjusted downward to R/PET>0.2. The threshold of R/PET>0.2 was selected for model development. Because of marked climatic and ecological differences in regions, model development was done separately, then as a combined dataset, for the highland pattern (April-October) and coastal pattern (November-March) rainfall zones.

Statistical analysis by the Spearman correlation coefficient (Table 1) revealed a significant direct relationship of percent prevalence with total annual GDD if R/PET>0.2, potential malaria generations per year (*Rho* 0.29496, p <0.0001) and to both mean mosquito adult (*Rho* 0.22438, p 0.0030) and larvae stages (*Rho* 0.18764, p 0.0134). Prevalence was related to annual PET (0.20695, p <0.0063) but not significantly related to raw annual rainfall or the annual R/PET ratio. There was an indirect relationship with Eritrea's highly variable altitude features (Figure 1) (*Rho* -0.33244, p<0.0001) and average annual mean temperature (*Rho* -.2739, p 0.0003).

Relative risk maps were prepared for annual GDD for both the highland (Figure 2) and coastal transmission patterns (Figure 3). GDD were accumulated conditional on a monthly R/PET ratio of >0.2. GDD values were summed for sites where overlapping coastal and highland rainfall patterns occur, resulting in a combined map on potential malaria generations per year (annual GDD 116) that represents a reference 'normal' annual risk pattern for Eritrea (Figure 4) based on long-term (30-year-average) climate data. No transmission was found at highland sites with <2 potential generations per year

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or at coastal sites with <6 potential generations per year. Maximum values of over 14 potential generations per year were found at sites in warm, wet regions. No transmission was found at average annual mean monthly temperatures of below 18°C or above 30°C, with optimum development between 20°C and 30°C during months in which R/PET exceeded the 0.2 soil moisture threshold (Figure 5). Apparent diminishing suitability was observed at >28°C and >12 generations per year.

For the fourth climate surface variable, the *product* of GDD and the R/PET ratio was calculated to create a GDD-water balance model (Figure 6) that represents a continuous gradient of thermal-moisture regime *in lieu* of the models based on the >0.2, >0.5 and >1.0 soil moisture thresholds. This model was best correlated (Table 1) with the prevalence survey data (*Rho*=0.3521, *p*0.0001). The marked differences in seasonality of transmission pattern found in Eritrea is illustrated in Figure 7 for monthly values of the 'gradient model' index at example sites in Dasse, Emkula and Erafale, which are representative of the coastal (a), highland (b), and overlapping (c) transmission patterns, respectively. For comparison of the two models, a scatter diagram of the potential generations per year model based on the R/PET >0.2 threshold is shown in Figure 8 and the product of GDD and R/PET in Figure 9. The latter is the product of a continuous gradient of two fundamental climate features at 173 survey sites, thermal and hydrological regime, providing an index of GDD that is 'weighted' based on a water balance-derived ratio that represents the soil moisture/surface water regime at each site.

A comparison of the 'threshold model', based on potential generations per year if R/PET>0.2, and the 'gradient model', based on the product of GDD and R/PET>0.2, revealed major differences in statistical correlation to fundamental climate variables (Table 1). A moderate to strong significant relationship was observed for the potential generations per year threshold model and altitude, average annual mean temperature, rainfall, annual PET and the annual R/PET ratio. By contrast, the 'gradient model', was not significantly related to altitude, average annual mean temperature or annual PET, but moderately correlated with both annual rainfall and the annual R/PET ratio. This indicates differences in the fundamental basis of the two model approaches, specifically the decreased relative importance of thermal regime and increased emphasis on moisture regime implicit in the gradient model as compared to the threshold model. More accurate reflection of surface moisture regime by the gradient model may account for the significant relationship of the gradient model to mosquito adult and larvae abundance and the lack of significant correlation with the mosquito life cycle by the potential generations per year threshold model. The candidate models tested had moderate to strong autocorrelation. The gradient model, conditional on a R/PET ratio of >0.2, provided the best 'fit' to percent prevalence and mosquito intermediate host data (Table 1).

DISCUSSION

Agroclimatic data and growing degree day-water balance spatial analysis methods were used in these studies to describe potential risk of malaria based on climate suitability for

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the life cycle progression of the *P. falciparum-An. arabiensis* system in Eritrea. Two models were developed as candidates for future use: Model 1, a 'Threshold Model' based on monthly accumulation of growing degree days, conditional on a water balance soil moisture content of >20% of capacity (R/PET>0.2), and Model 2, a 'Gradient Model' based on monthly accumulation of the *product* of growing degree days and the monthly R/PET ratio, also conditional on a soil moisture content of >20% of capacity.

In the prediction model developed by Craig and others[8] for continental Africa, the authors indicated the need to adjust and refine the model in the future, particularly for use in peripheral areas of North Africa where a shorter transmission season (3 months vs 5 months elsewhere) and different rainfall patterns occur. Additionally, no provision was made for evaluating relative risk in 'stable' transmission zones. Snow et al.[5] later reported on a model that correctly identified 77% of low (<20%), moderate (20-69%) and high (>70%) relative risk sites among 124 villages in stable, endemic areas of Kenya based on rainfall, temperature and normalized difference vegetation index (NDVI). We propose that the GDD-water budget and potential generations per year concepts described in the current work provide an alternative measure of relative malaria risk in zones characterized as unstable and/or stable transmission areas.

Evaluation of Model 1, based on the R/PET>0.2 threshold, suggests that the potential generations per year concept can be used as an indicator of the chance of annual transmission associated with periods of stable, extensive microclimate conditions for the *P. falciparum-An. arabiensis* system. Potential generations per year is proposed to be a

more intuitive and meaningful measure than a simple GDD index, since it is tied to a species-specific base temperature (>16°C) and a cumulative GDD requirement for completion of the development of *P falciparum* in *An arabiensis* (116 GDD) which is accumulated conditional on meeting a monthly R/PET water balance threshold (>0.2). R/PET is a widely available monthly measure of climate regime that better reflects surface hydrologic conditions of microhabitats than simple rainfall, including estimation of soil moisture content and 'surplus water', an indicator of surface water and runoff. When linked to the R/PET >0.2 threshold, the model successfully accounted for the divergent seasonal rainfall pattern and malaria transmission cycles found in the coastal and highland regions of Eritrea (Figures 2-5). The R/PET threshold of >0.5 missed important coastal zone transmission sites and surplus water (R/PET>1.0) was observed only in selected months in the wettest zones of Southwest Eritrea.

Based on the 'threshold model', no malaria transmission was found at sites with less than two potential generations per year or at sites with average annual mean monthly temperatures of below 18°C or above 30°C, with optimum development between 23°C and 30°C during months in which R/PET exceeded the 0.2 soil moisture threshold (Figure 6). These results are consistent with thermal regime requirements used by others for malaria,[1,8] and support use of 18°C as the minimum temperature for malaria under field (not laboratory) conditions as proposed by Kleinschmidt and others.[1] Analysis also indicates a depressive 'heat stress' effect on the life cycle at high ambient temperatures[1,8]. In the laboratory, ookinete development time shortens as temperatures increase from 21°C to 27°C, whereas higher temperatures of 30°C to 32°C interfere with developmental

processes.[19] Results suggest that 1) optimum conditions for malaria transmission occur at sites with moderate temperatures and 6-11 potential generations per year in months in which soil moisture exceeds the R/PET>0.2 threshold; 2) that there is a need to systematically account for heat stress at high temperatures that result in decreasing suitability for propagation and transmission of malaria and 3) the marked differences in seasonality of transmission pattern found in Eritrea can be predicted, as shown in Figure 7 for sites in Dasse, Emkula and Erafale, which represent the coastal (a), highland (b), and overlapping (c) transmission patterns, respectively. Maximum malaria transmission would be expected to follow a developmental 'lag period' of approximately 3 months.[21]

A recent review of malaria models emphasizes the need to develop reference models grounded in the underlying biology of the disease and parasite-intermediate host systems and avoidance of statistical, curve-fitting descriptions of data that may not be related to the processes that generate epidemiological data.[22] Water balance analysis and the generations per year concept are proposed to indicate the potential, not actual, chance that malaria transmission cycles can be completed in periods when conditions in potential mosquito microhabitats favor mosquito populations and malaria parasite development and transmission. Model 1 thus assumes potential availability of *An. arabiensis* microhabitat foci in months that exceed the R/PET >0.2 threshold. The primary vector of malaria in Eritrea is considered to be *An. arabiensis*, a zoophilic species with very close associations with livestock, especially cattle. It is found more often in drier savanna areas and rests post-bloodmeal both inside structures and in the outside environment. Larval

habitats vary from rice fields to small pools and muddy rainwater accumulations in animal hoof prints and tire ruts.[23]

Model 2, the 'gradient model' (Figure 9), based on the product of GDD and R PET, provided a better statistical correlation with malaria infection prevalence survey values (*rho*=0.3521, *p*0.0001) than the 'threshold model' (Figure 8), based on GDD above the 0.2 soil moisture threshold (*rho*=0.2823, *p* 0.0007). The gradient model uses the product of GDD and the entire range of the R PET ratio, including soil moisture level and surplus water, to calculate a risk index value at different sites. For example, a R PET ratio of 0.1 represents an estimated soil moisture of 10% water holding capacity that would be expected to lead to a lower risk index than a 1.5 R PET ratio, representing soil saturation with 0.5 surplus water. The rationale is that increasing water availability favors transmission by leading to a expansion of the distribution and abundance of potential mosquito vector microhabitat and that drier conditions lead to a relative contraction of the extent of suitable microhabitats. The potential generations-per-year chart shown in Figure 9 thus represents values that are 'weighted' to produce an index based on site-specific thermal factors and a hydrological regime gradient of water balance-derived soil moisture and surface water on a broad geographic scale. Based on current work in Eritrea, the Model 2 'gradient model' best predicted malaria risk.

When 28 sites with the coastal transmission pattern (with no overlapping highland pattern transmission) were considered separately, no significant relationship was found with either the gradient model or the threshold potential generations per year model. This

may be due to the limited sample size of survey sites (28 of 173), the low prevalence rates (0-11%), or the lesser relative importance of rainfall-dependent climate in an area where microhabitats are often found in irrigated areas or along water bodies.[16, 17] Mean mosquito numbers were related to malaria prevalence and to malaria generations per year if R/PET > 0.5 (but not if R/PET >0.2) suggesting a relationship with available surface water. Evaluation of spatial distribution within the GIS by 'predictive value' indicated that >95% of sites with coastal transmission pattern of malaria could be spatially predicted as endemic by either the GDDxR/PET gradient model or the Potential Generations/Year threshold model. The geographic distribution of sites classified as having the highland transmission pattern or as having characteristics of overlapping coastal and highland patterns were also predicted spatially within the GIS at > 95% agreement with survey data.

The value of the gradient and threshold models, based on GDD-water balance principles, remains to be validated by additional work under conditions found elsewhere in other malaria endemic areas. Support for this approach is provided by Lindsay and others who successfully modeled the continental distribution of *An. arabiensis* and *An. gambiae* in Africa, the former being mainly found in drier savannahs and the latter in wetter forested zones,[23] and suggested R/PET was a useful indicator of suitable regional environments for mapping the distribution of these mosquito species. In other work, Patz and others[6] successfully related local water budget analysis to malaria transmission using *daily* climate data from a single climate station in an intensively studied area in the northwest Lake Victoria area of Kenya; it is relevant that the minimum soil moisture

value consistent with malaria developmental cycles was also found to be >0.2 of soil water holding capacity.

The gradient and threshold climate models described here define baseline *30-year-average* reference mapped values that are needed for prediction of malaria risk variation in *individual* years using climate surface analysis within a GIS. These reference maps can be used in control programs to predict higher or lower *climate-based* annual risk of malaria, and potential epidemics, by comparison to similar maps created from data of the current year or other individual years. By interpolation of available daily data from a number of climate stations, creation of 'near real time' climate risk surfaces based on model values is possible using GIS methods. Thus, a given climate surface grid cell (5x5 km) containing a site of interest can be selected by 'point and click' functions within a GIS to provide current climate-based risk assessment values as compared to 30-year-average reference model values, or to other individual years. Other relevant environmental data that correspond to that grid, such as human population, soils or satellite sensor data can similarly be considered in more comprehensive models that include factors in addition to climate data.

In previous malaria model development efforts in Eritrea, a GIS risk analysis system for Eritrea was developed based on altitude, rainfall and vegetation index (NDVI) derived from earth observing satellite data[16,18]. Other variables, including distance to water bodies, human population data, health center service area density, and larva and adult mosquito population surveys were also examined but were not sufficiently definitive

statistically to be included in the model, although this may be related to the coarse geographic scales of spatial data used. Further development of current results in Eritrea should be directed at: 1) research on climate models using daily climate data and parasitological data from individual years, 2) extrapolation and validation of models in other countries and regions, and 3) use of higher resolution maps and satellite sensor data on environmental features, population factors and health care systems to identify factors that may underlie the typically high local variability of malaria transmission. Figure 10 illustrates the relationship of ranked Model 2 (gradient model) index values to survey prevalence at Highland sites in Eritrea for April to October ($p<0.0001$), illustrating the high local site variability typically observed due to local factors at sites within otherwise 'climate permissive' regional conditions in malaria zones. Further work is also needed to refine the model by defining field effects of heat stress on development and propagation of the *An. arabiensis-P. falciparum* system .

In conclusion, results of the current study indicate that: 1) agroclimatic data and growing degree day-water balance spatial analysis methods can be used to describe potential risk of malaria based on the suitability of the environment for life cycle progression of the *An. arabiensis-P. falciparum* system. As a component of comprehensive risk assessment models, this may enable future near real-time disease prediction and interventions by health system managers. Results further suggest the potential for more precise characterization of near real-time microhabitat conditions suitable for *Plasmodium-Anopheles* systems using GDD and water balance parameters generated by analysis of *daily* climate data using methods similar to the two-level soil

moisture model and surplus water parameters developed for *Fasciola*.[12] The latter is a disease of cattle and sheep transmitted by amphibious snails that prefer habitats like that of *An. arabienesis*. Similar modeling tools for near real-time risk assessment and control program decision support were recently developed for schistosomiasis mansoni in East Africa.[14, 24] Based on 'settable' growing degree day and water balance analysis thresholds grounded on the underlying biology of a given disease, such tools[5] and new-generation satellite sensor data[26] promise to be applicable to malaria and to a number of other environmentally sensitive diseases. New efforts are underway by USAID, the United States Geologic Survey, the UN Food and Agricultural Organization and other development agencies to develop a Spatial Database Infrastructure (SDI) for broad use in sustainable development for Africa.[26] These trends and recent research results indicate that useful health applications aimed at defining 'where, when and how bad' for major human and veterinary diseases on a site-specific basis using real-time spatial decision support systems are achievable goals.

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Bureau for Economic Growth, Agriculture, and Trade (EGAT), Office of Agriculture via the Geographic Information for Sustainable Development (GISD) initiative jointly led by USAID and the US State Department, http://www.opengis.org/gisd. The opinions expressed herein are those of the authors and do not necessarily reflect the views of UNMEE or USAID.

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FOOTNOTES:

[a] OptiMal Rapid Diagnostic Test Kit, Flow Inc., Portland, OR

[b] ESRI, Redlands, CA

[c] The 'HealthWhere' module of the USAID Almanac Characterization Tool. 'HealthWhere: A spatial decision support system for control of environmentally sensitive diseases'.

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FIGURE LEGENDS:

Figure 1. Elevation (m) in relation to *P. falciparum* infection prevalence rates at 173 survey sites.

Figure 2. Highland transmission pattern as defined by the threshold model (Model 1) using data on cumulative growing degree days from April through October, if soil moisture content exceeds 20% of holding capacity based on the ratio of monthly rain/potential evapotranspiration (R/PET>0.2).

Figure 3. Coastal transmission pattern as defined by the threshold model (Model 1) using data on cumulative growing degree days from November through March, if soil moisture content exceeds 20% of holding capacity based on the ratio of monthly rain/potential evapotranspiration (R/PET>0.2).

Figure 4. Threshold model data (Model 1) on cumulative potential generations per year (GDD/116) for months in which the ratio of rain/potential evapotranspiration exceeded soil moisture content of over 20% of holding capacity (R/PET>0.2).

Figure 5. Average annual mean temperature as compared to prevalence at 173 survey sites in Eritrea. Monthly mean temperature for individual months exceeded 30°C at some coastal sites, but not during the wet transmission season.

Figure 6. Model 2 (gradient model) malaria risk assessment using the product of cumulative monthly growing-degree-days times the rain/potential evapotranspiration ratio, if the R/PET ratio >0.2.

Figure 7. The marked differences in seasonality suitability is illustrated by the 'gradient index' (the product of GDD and R/PET) for example sites in Dasse, Emkula, and Erafale.

which are representative of the highland (a), coastal (c) or overlapping (b) transmission pattern, respectively.

Figure 8. Potential generations/year weighted for a continuous gradient of hydrologic regime by annual summation of the monthly product of potential generations per year and the water budget ratio of monthly rain and potential evapotranspiration (GDD/116 x R/PET).

Figure 9. Potential *Plasmodium falciparum* generations/year based on accumulated growing degree days (GDD) if soil moisture in the crop root zone (rain/potential evapotranspiration) is >20% saturated. The accumulated value of 116 GDD is required for development of one generation of *P. falciparum* in *An. arabiensis*.

Figure 10. The relationship of ranked Model 2 (gradient model) index values to prevalence ($p<0.0001$) at highland survey sites in Eritrea for April-October, illustrating the typical wide variation in malaria risk due to local factors at sites within otherwise 'climate permissive' regional zones.

Table 1. Spearman Correlation Coefficient analysis of Malaria Prevalence %, the Annual 'Gradient model' index* and the Potential Generations per Year 'threshold model'~ as compared to *P. falciparum* prevalence, mean number of adult and larval *Anopheles* mosquitoes, altitude and basic climate variables at 173 survey sites with highland (September-November) or coastal (February –March) transmission pattern.

		Prevalence %	Mean Mosquito	Mean Larvae	Altitude	Annual Mean Temperature	Annual Rain	Annual PET**	Annual R PET
Prevalence%	Rho P		0.2244 0.0030	0.1876 0.0134	-0.3324 <0.0001	0.2612 0.0005	0.0416 0.5869	0.2066 0.0063	0.0143 0.8520
*GDD x R PET if >0.2	Rho P	0.3511 <0.0001	0.2598 0.0006	0.1932 0.0109	-0.0015 0.9847	-0.0050 0.9479	0.4932 <0.0001	-0.071 0.3519	0.3912 <0.0001
~Potential Generations/ Year if >0.2	Rho P	0.2950 <0.0001	0.0257 0.7370	0.0318 0.6781	-0.4914 <0.0001	0.6715 <0.0001	-0.2739 0.0003	0.61747 <0.0001	-0.3436 <0.0001
Total Annual GDD	Rho P	0.2951 <0.0001	-0.0454 0.5269	-0.0128 0.8677	-0.8016 <0.0001	0.9493 <0.0001	-0.7177 <0.0001	0.9769 <0.0001	-0.7633 <0.0001
Annual Mean Temperature	Rho P	0.2612 0.0005	-0.0439 0.5667	-0.0129 0.8658	-0.7640 <0.0001		-0.7127 <0.0001	0.9422 <0.0001	-0.7544 <0.0001
Annual Rain	Rho P	0.0416 0.5869	-0.0769 0.3147	0.0011 0.9883	0.6305 <0.0001	-0.7126 <0.0001		-0.7934 <0.0001	0.9838 <0.0001
Annual PET	Rho P	0.2066 0.0063	-0.0769 0.3147	0.0011 0.9883	-0.7953 <0.0001	-0.9422 <0.0001	-0.7934 <0.0001		-0.8397 <0.0001
Annual R PET	Rho P	0.0143 0.8520	0.1336 <0.0798	0.0456 0.5515	0.6699 <0.0001	-0.7544 <0.0001	0.9838 <0.0001	-0.8397 <0.0001	
Annual R PET if>0.2	Rho P	0.1136 0.367	0.2254 0.0027	0.1042 0.1725	0.5556 <0.0001	-0.6484 <0.0001	0.9538 <0.0001	-0.7395 <0.0001	0.9424 <0.0001

*GDD x R PET = Sum of monthly growing degree days x the Rain PET ratio if soil water holding capacity >0.2

~Potential Generations per Year based on GDD if soil water holding capacity >0.2

**PET = Potential Evapotranspiration

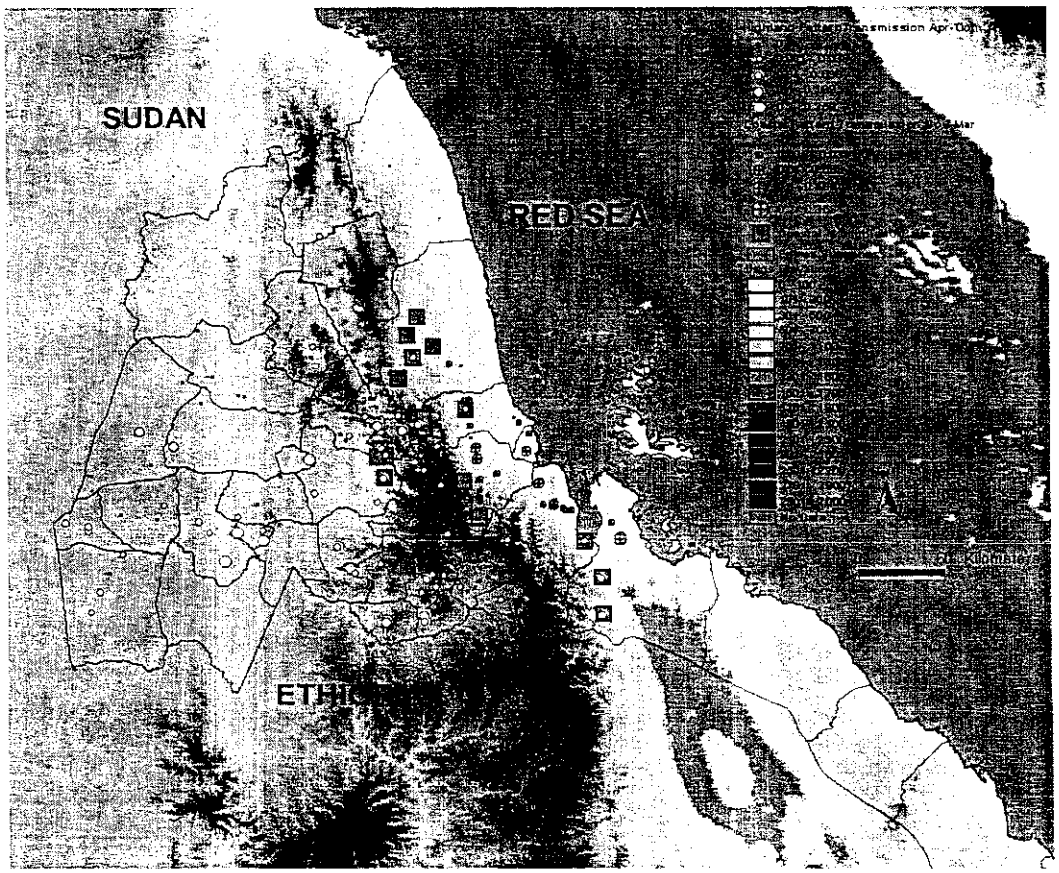
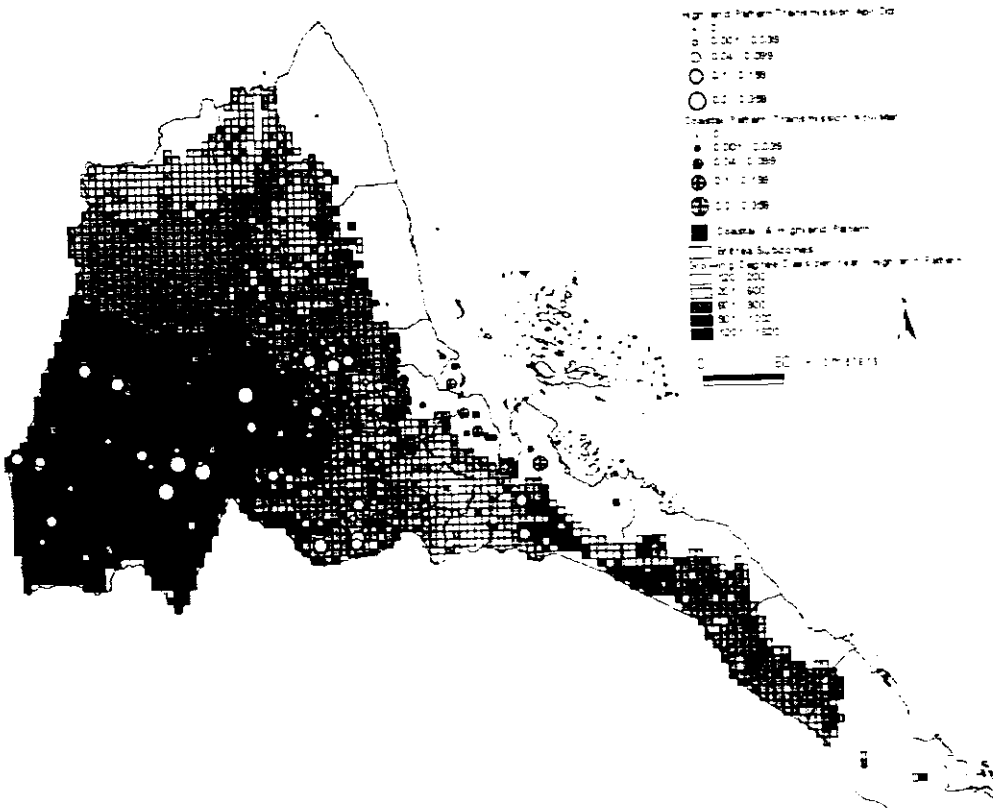


Figure 1.



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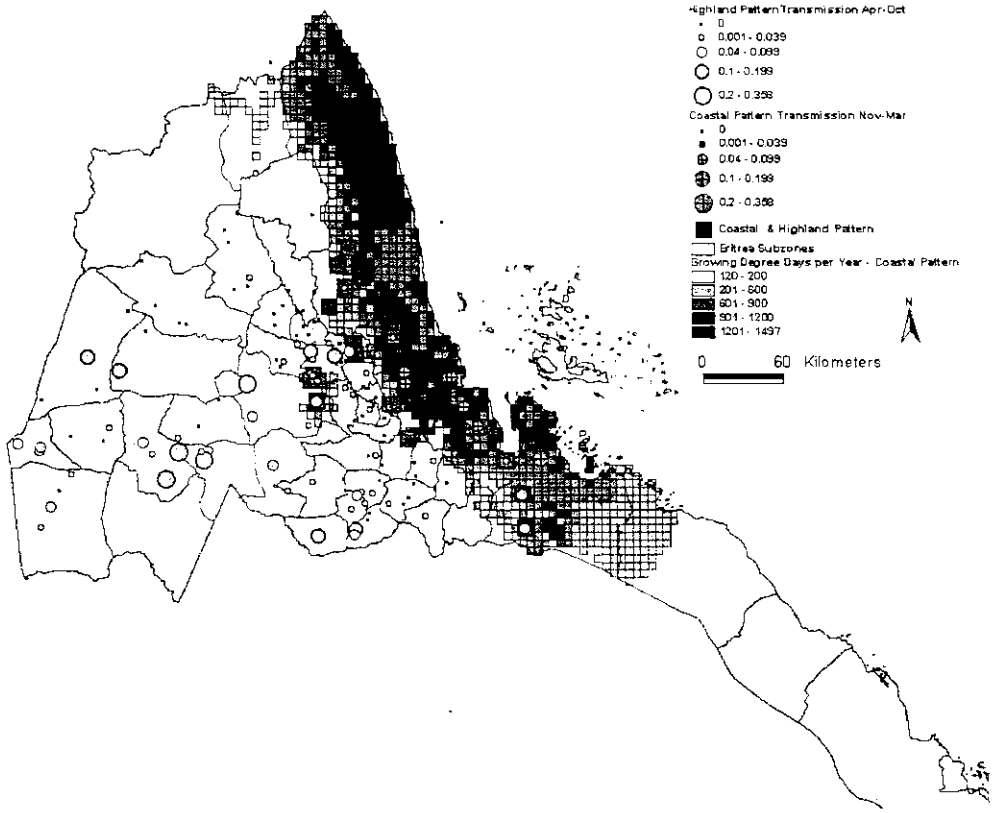

Highland Pattern Transmission Apr-Oct
0
0.001 - 0.039
0.04 - 0.099
0.1 - 0.199
0.2 - 0.358
Coastal Pattern Transmission Nov-Mar
0
0.001 - 0.039
0.04 - 0.099
0.1 - 0.199
0.2 - 0.358
Coastal & Highland Pattern
Eritrea Subzones
Growing Degree Days per Year - Coastal Pattern
120 - 200
201 - 600
601 - 900
901 - 1200
1201 - 1497
N
0
60 Kilometers

Figure 3.

320

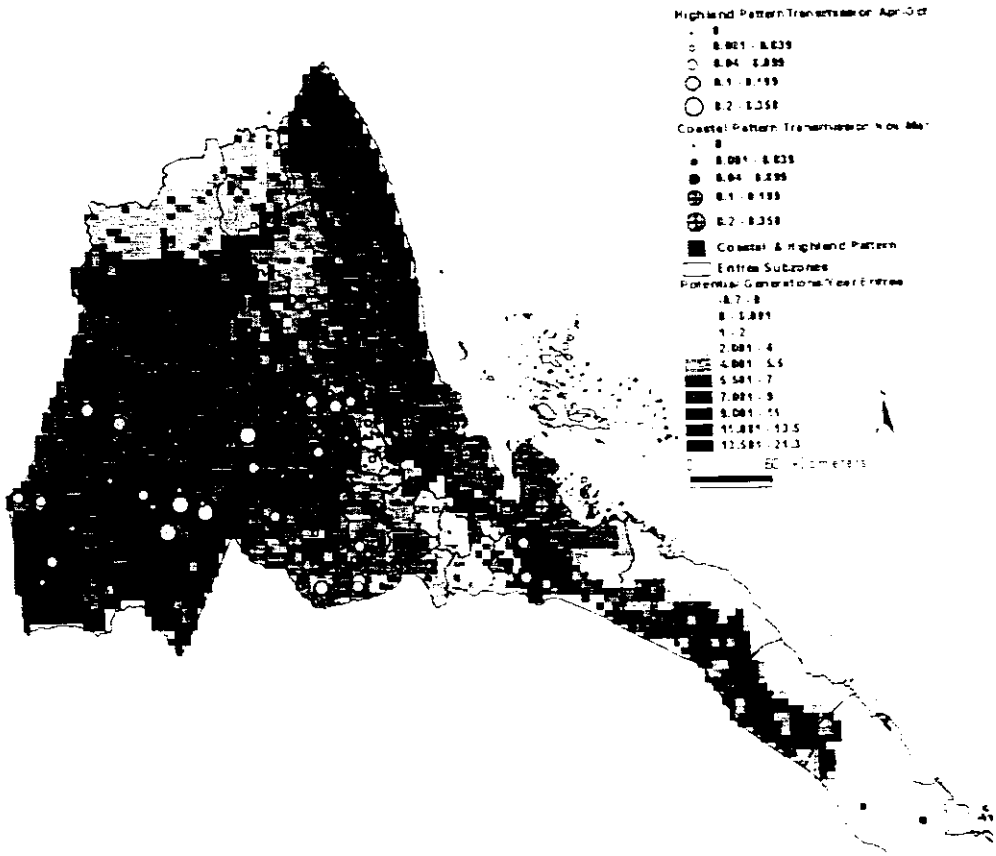


Figure 4.

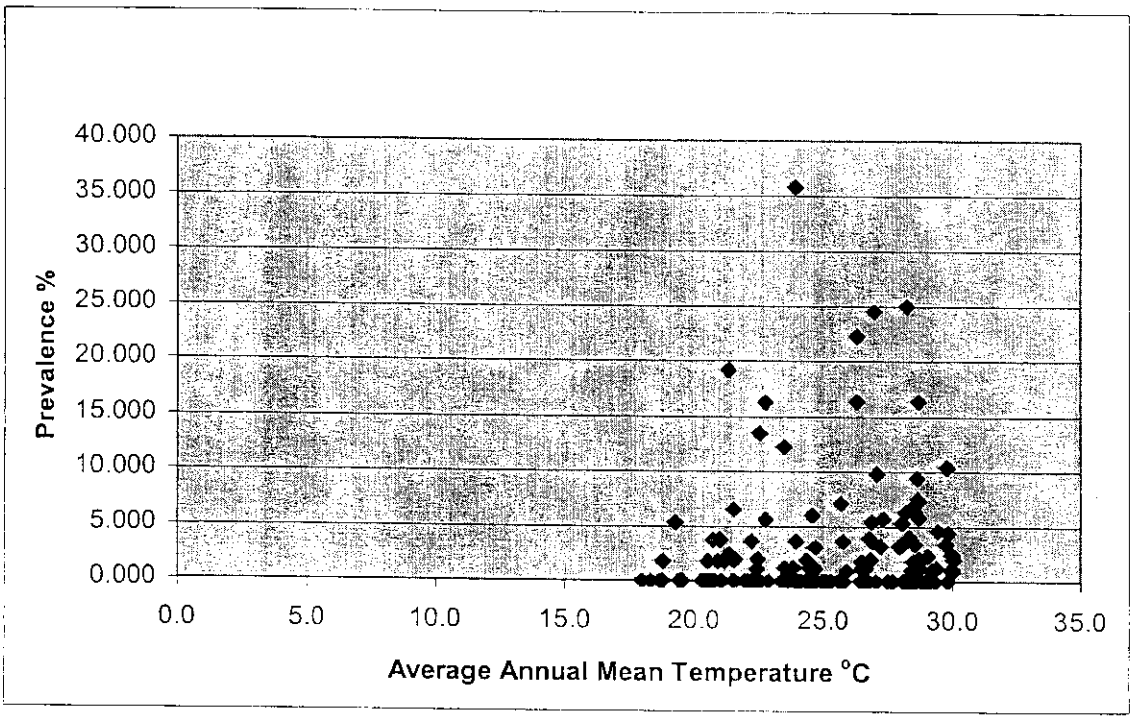

40.000
35.000
30.000
25.000
20.000
15.000
10.000
5.000
0.000
Prevalence %
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
Average Annual Mean Temperature °C

Figure 5.

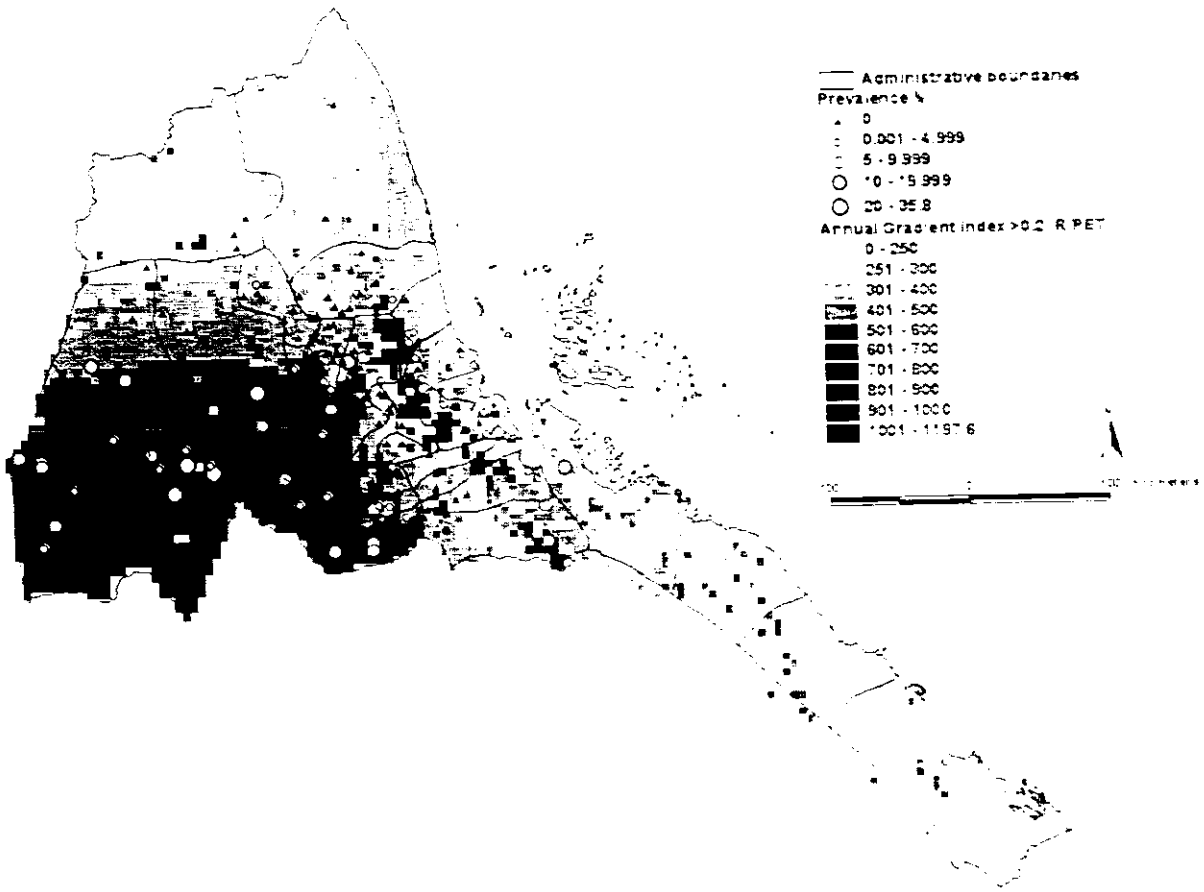
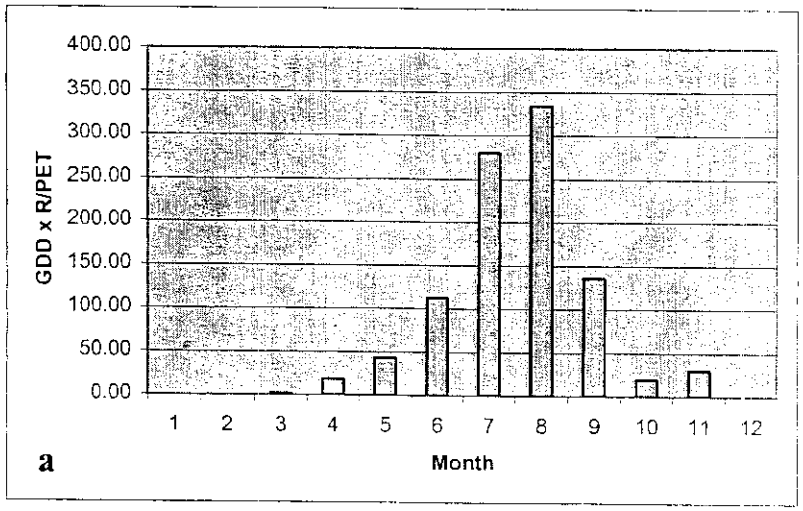
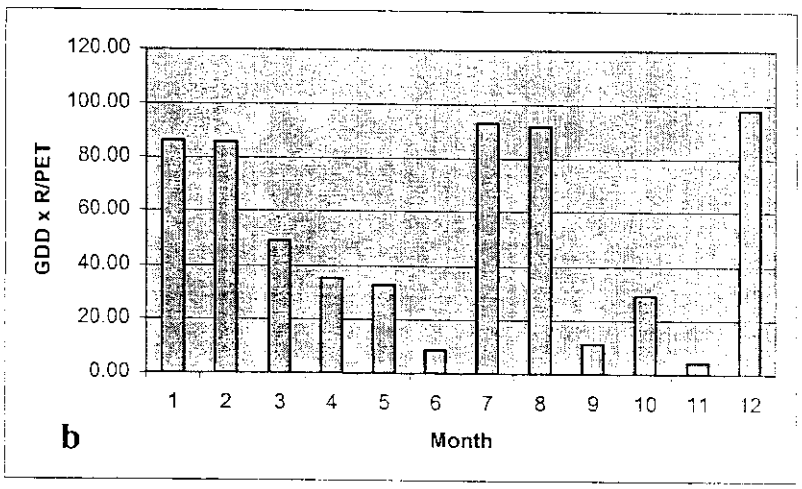

Administrative boundaries
Prevalence %
0
0.001 - 4.999
5 - 9.999
10 - 15.999
20 - 35.8
Annual Gradient index >0.2 R PET
0 - 250
251 - 300
301 - 400
401 - 500
501 - 600
601 - 700
701 - 800
801 - 900
901 - 1000
1001 - 1197.6

Figure 6.


400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
GDD x R/PET
1 2 3 4 5 6 7 8 9 10 11 12
a
Month


120.00
100.00
80.00
60.00
40.00
20.00
0.00
GDD x R/PET
1 2 3 4 5 6 7 8 9 10 11 12
b
Month

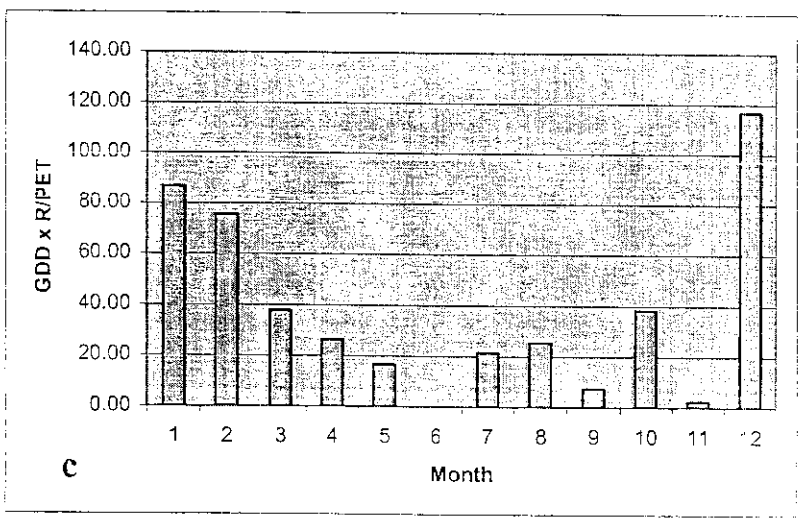

140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
GDD x R/PET
1 2 3 4 5 6 7 8 9 10 11 12
c
Month

Figure 7.

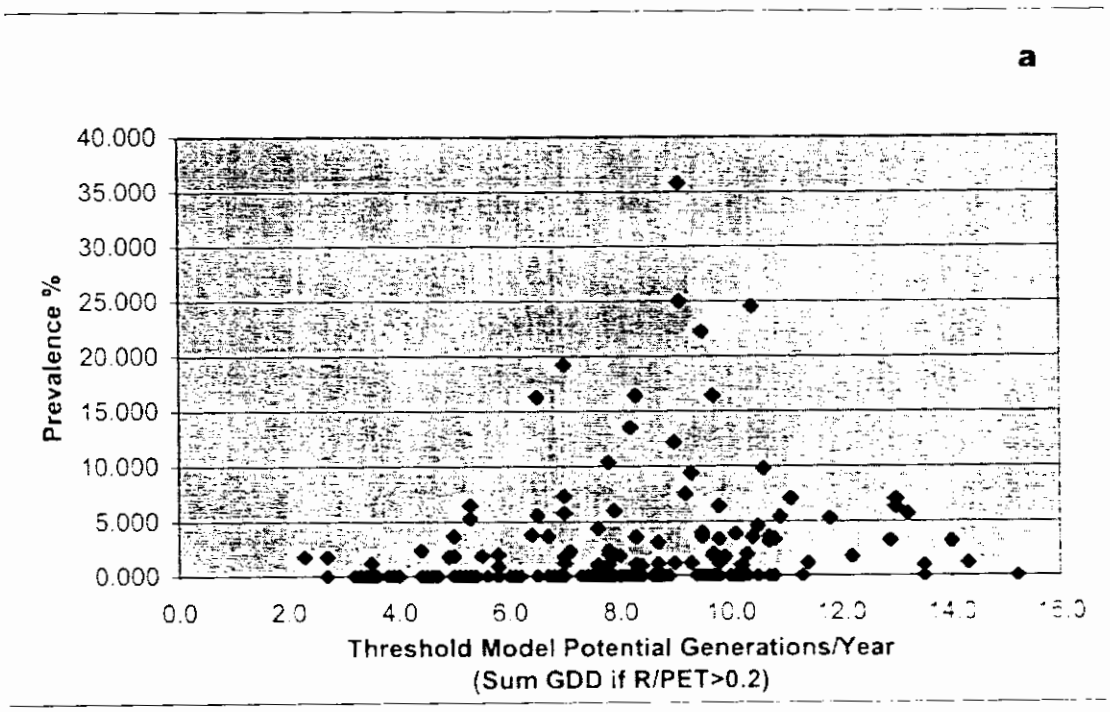

a
40.000
35.000
30.000
25.000
20.000
15.000
10.000
5.000
0.000
Prevalence %
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
Threshold Model Potential Generations/Year
(Sum GDD if R/PET>0.2)

Figure 8.

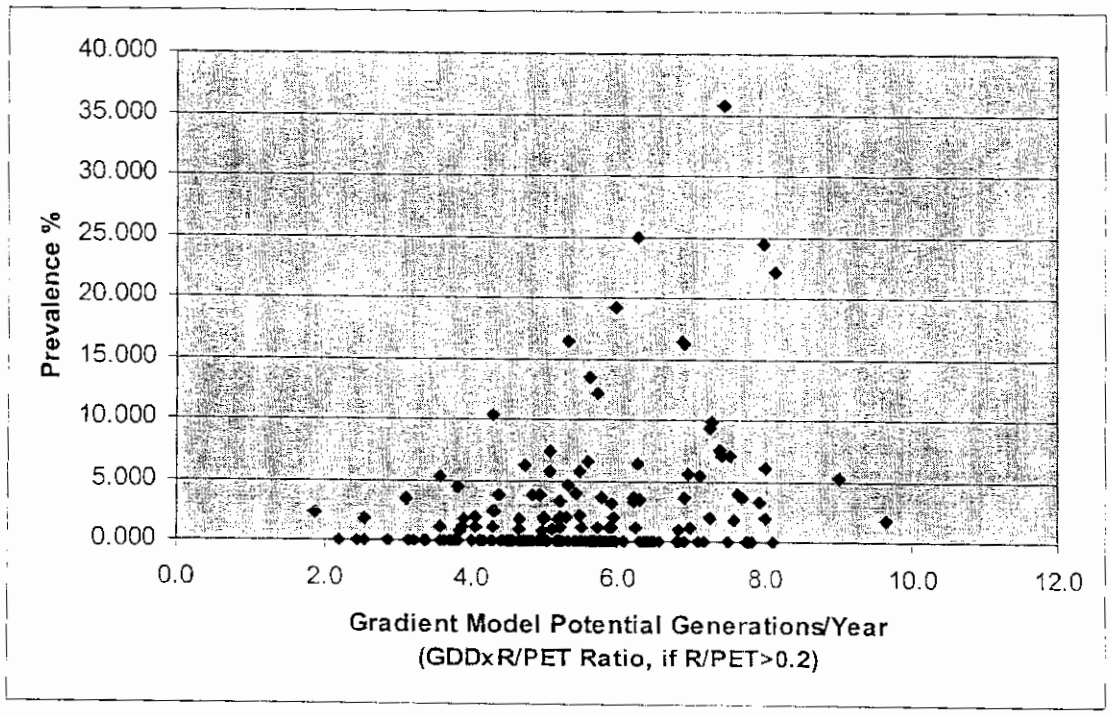

40.000
35.000
30.000
25.000
20.000
15.000
10.000
5.000
0.000
Prevalence %
0.0
2.0
4.0
6.0
8.0
10.0
12.0
Gradient Model Potential Generations/Year
(GDDxR/PET Ratio, if R/PET>0.2)

Figure 9.

326

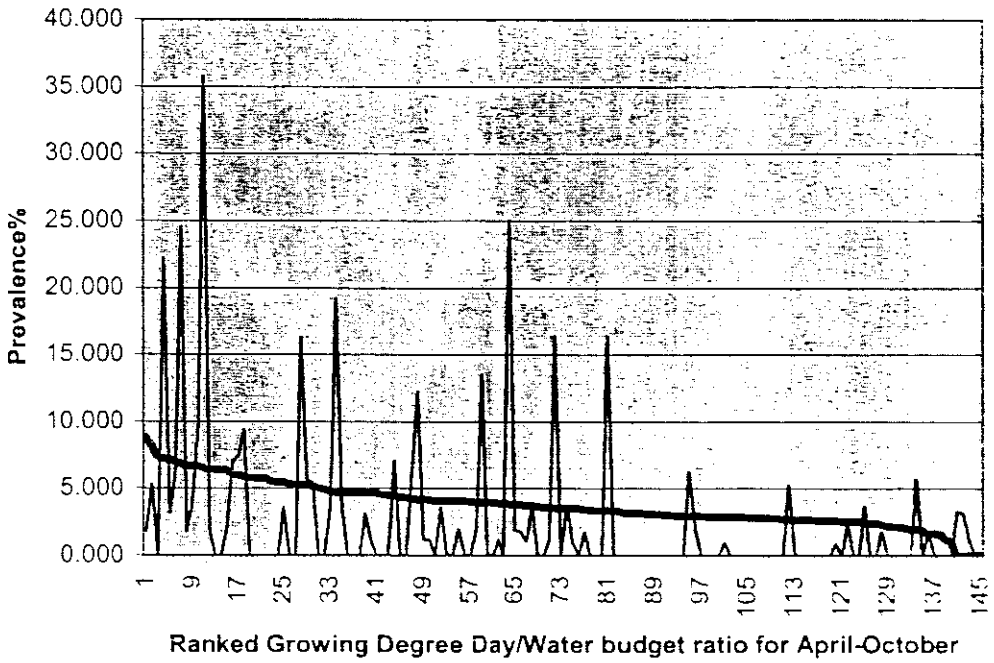

40.000
35.000
30.000
25.000
20.000
15.000
10.000
5.000
0.000
Provalence%
1
9
17
25
33
41
49
57
65
73
81
89
97
105
113
121
129
137
145
Ranked Growing Degree Day/Water budget ratio for April-October

Figure 10.

GISD Project
Annex 5

Subcontract With

Livestock Early Warning Systems (LEWS)
Texas A&M University
(Global Livestock CRSP)
IFDC Contract # 01594/01

1. Project Summary Page
2. Project Memorandum of Understanding
3. Project Final Report

	Project Summary Page
MOU Lead Implementation Organization	**Livestock Early Warning Systems (LEWS)** **Texas A&M University** **(Global Livestock CRSP)**
Contact Person	Dr. Jerry Stuth PI Global Livestock CRSP-LEWS Dept. Rangeland Ecology and Management TAMU 22126 Texas A&M University College Station, TX 77843-2126, USA Telephone: 979/845-5548 Fax: 979/854-6430 jwstuth@cnrit.tamu.edu
Project/Program and Statement of Work	Target Region 2: African Great Lakes: **Multi-Scale Aggregation of Biophysical Processes Affecting Pastoral Communities in East Africa** The GL CRSP will add monitoring points outside of the current zones established for geo-statistical analysis in Southern Kenya that will allow more robust kriging and co-kriging of regional spatial analyses. This will mean that some points will have to be added between the Southern Ethiopia Zone and Northern Kenya and between Northern Tanzania and Southern Kenya. A description of the activities to be undertaken by GL CRSP, technical procedures to be followed, deliverables required, and estimated schedule are presented in Attachment 1. Attachment 1 is incorporated as an integral part of this Memorandum of Understanding (MOU).
Collaborating Institutions	Tanzania Environmental Management Council Institute of Marine Sciences University of Dar es Salaam Interagency World Summit Geographic Information Project
IFDC Contract Number	01594/01
Budget Amount	Signed contract with Texas A&M for $45,000 on November 5, 2001
Amendment(s)	None
Extension Ending Date	

IFDC01594 01

IFDC INTERNATIONAL FERTILIZER DEVELOPMENT CENTER • MUSCLE SHOALS, ALABAMA 35662 USA
P.O. BOX 2040 • 256-381-6600
EMAIL-general@IFDC.org
TELEFAX NO. 256-381-7408

Memorandum of Understanding

Between

International Fertilizer Development Center
PO Box 2040
Muscle Shoals, AL 35662, USA

And

The Texas Agricultural Experiment Station (TAES)
of the
Texas A&M University System
College Station, TX 77843-2126, USA

October 1, 2001

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The International Fertilizer Development Center (hereinafter referred to as IFDC) is a public international organization (PIO) dedicated to increasing sustainable agricultural production through the improved use of yield enhancing technologies. TAES has submitted a proposal to USAID to support development of the application of integrated remotely sensed weather data, point-based biophysical modeling and spatially stratified animal and vegetation data to serve decision makers concerned with the welfare of pastoral communities in East Africa. In order to carryout the work described herein, IFDC and TAES hereby agree to the following terms and conditions:

1.0 INTRODUCTION AND STATEMENT OF WORK

The United States Agency for International Development (USAID) has entered into an Agreement with IFDC for IFDC to undertake a project entitled "Quick Start for Agriculture in Africa" to support the Geographic Information for Sustainable Development (GISD) project leading up to the World Summit on Sustainable Development (WSSD).

IFDC will provide USAID/EGAD/AFS with logistical and management support to the various partners involved in the implementation of the GISD project, including transferring and providing overall fiscal oversight to specific "pass-through" funds to selected partners who are being asked to implement specific GISD activities. This will include work already identified in specific proposals from the NRC, OGC, and several other groups located in the four Target Regions: Upper Niger Basin, African Great Lakes Region, the Kenya-Tanzania Coastal Zone, and the Limpopo/Zambeze River Basin Region of southern Africa.

IFDC will work in close collaboration with the technical officers within USAID providing oversight: Note: The Overall Coordinator is Robert E. Ford, AEMD – Agricultural Enterprise and Market Development Division within USAID's office of Agriculture and Food Security. Robert E. Ford is the Chair of the GISD-IWG for Regional Applications sub-group.

Close coordination must also occur with co-Chairs of the GISD-IWG for each sub-region. They are: Barbara Best (G/ENV) for the Kenya-Tanzania CZM Activity; Paul Bartel and Jon Anderson (AFR-SD) for the Four Corners/Limpopo/Zambezi Basin region; Robert Ford for the Great Lakes/Great Horn of Africa Region; and Mike McGahuey (USAID/AFR-SD).

TAES will add monitoring points outside of the current zones established for geo-statistical analysis in Southern Kenya that will allow more robust kriging and co-kriging of regional spatial analyses. This will mean that some points will have to be added between the Southern Ethiopia Zone and Northern Kenya and between Northern Tanzania and Southern Kenya. A description of the activities to be undertaken by GL CRSP, technical procedures to be followed, deliverables required, and estimated schedule are presented in Attachment 1, which is incorporated as an integral part of this Memorandum of Understanding (MOU).

2.0 SPECIFIC CONDITIONS

2.1 Effective Dates of MOU

The effective dates of this MOU are October 1, 2001-September 30, 2002.

2.2 Finance

The work to be performed under this MOU is being financed by USAID with all funds channeled to IFDC. IFDC shall provide funding to TAES in accordance with the terms and conditions described in this MOU. TAES shall develop subagreements as necessary to support funding arrangements and the work to be performed by its collaborating institutions. The estimated funds available to TAES total US $45,000 (forty-five thousand) as follows:

Item	Total US $
Spatial Integration of Goods	7,000
Accelerating of Fecal Monitoring System	18,000
Communication Enhancement	15,000
Capacity Building at DMC/RCMRD	5,000
TOTAL	**45,000**

2.2.1 Use of Funds

IFDC has fiduciary responsibility of funds received from USAID. Under the terms of this MOU, all funds provided to TAES shall be utilized solely for the purposes indicated in the budget under 2.2. Said funds shall cover all expenditures necessary for the services to be performed by and or arranged by TAES. IFDC shall not be responsible for any additional costs (i.e., above US $45,000) incurred in the performance of the work described under this MOU.

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2.2.2 Allowable Costs

(a) TAES shall be reimbursed for costs incurred in carrying out the purposes of this MOU, which are reasonable, allocable, and allowable.

(b) Reasonable shall mean those costs that do not exceed those which would be incurred by an ordinarily prudent person in the conduct of normal business.

(c) Allocable shall mean those costs which are necessary to the MOU.

(d) Allowable shall mean those costs which are reasonable and allocable, and which conform to any limitations set forth in this MOU.

(e) Prior to incurring a questionable or unique cost, TAES is encouraged to obtain IFDC's written determination as to whether the cost will be allowable.

2.2.3 Payments

IFDC shall make payments to TAES subject to the receipt of funds from USAID and based upon receipt of an official invoice from TAES. The invoice may be faxed to the official IFDC Business Contact indicated in 2.6.1. The payments shall be made on a cost reimbursement monthly basis based upon TAES'S submission of financial reports, which substantiate costs incurred in the performance of this MOU.

2.2.4 Financial Reports

TAES shall provide to IFDC, within 20 days of the end of each month under this program, a financial report indicating funds expended under this MOU. The financial reports shall include accounting for all allowable costs incurred by TAES under the program in accordance with the line item budget amounts indicated in 2.2. Copies of documentation to support all costs for incurred in performance of work described in this MOU shall be provided to IFDC if requested by IFDC/USAID.

2.2.5 Audit

TAES shall maintain books, records, documents, and other evidence in accordance with TAES's usual accounting procedures to sufficiently substantiate charges to this MOU. IFDC and USAID reserve the right to examine and TAES agrees to make available all financial records and documents of TAES as related to this MOU. Any costs that are determined by either IFDC or USAID to be inconsistent with the terms and conditions of this MOU shall immediately be refunded to IFDC. TAES is subject to the audit guidelines and provisions of 22 CFR Section 226.26. In accordance with the provisions of OMB Circular A-133, TAES is obligated to comply with the requirements of OMB Circular A-133. TAES is required to have an audit in full compliance with the guidelines of OMB A-133 and agrees that a copy of the audit report will be submitted to IFDC's supervisor, Accounting Services, by TAES within thirty (30) days of completion of the audit.

2.2.6 Refunds

(a) If TAES earns interest on advances under this MOU prior to expending the funds for program purposes, TAES shall remit the interest to IFDC or deduct the same from subsequent invoices of planned monthly expenditures in accordance with 2.2.3.

(b) Funds not disbursed to TAES at the time the MOU expires or is terminated shall revert to IFDC, except for such funds encumbered by TAES by a legally binding transaction applicable to this MOU. Any funds advanced to but not expended by TAES at the time of expiration or termination of the MOU shall be refunded to IFDC except for such funds encumbered by TAES by a legally binding transaction applicable to this MOU.

(c) If, at any time during the life of the MOU, or as a result of final audit, it is determined that funds provided under this MOU have been expended for

BEST AVAILABLE

purposes not in accordance with the terms of this MOU, TAES shall refund such amount to IFDC.

2.3 Language

The MOU has been executed in English, which shall be the binding and controlling language for interpretation of the terms and conditions of this MOU.

2.4 Subagreements

It is understood that TAES may carryout the work described under this MOU in collaboration with others. It is further understood that funds provided to TAES may be used to support work carried out by collaborating institutions. TAES shall ensure that the specific conditions of this MOU (i.e., Section 2.0, Specific Conditions) shall apply to all such subagreements.

2.5 Revision of MOU Budget

(a) The approved MOU budget is the financial expression of TAES's program.

(b) TAES shall immediately request approval from IFDC when there is reason to believe that within the next 30 calendar days a revision of the approved MOU budget will be necessary for any of the following reasons:

- To change the scope or the objectives of the program and/or revise the funding allocated among objectives by more than ten percent of the total budget amount unless the schedule states otherwise.
- Additional funding is needed.
- TAES expects the amount of authorized funds to exceed its needs by more than $5,000 or five percent of the MOU budget, whichever is greater.

(c) Except as required by other provisions of this MOU specifically stated to be an exception from this provision, IFDC shall not be obligated to reimburse TAES for costs incurred in excess of the total amount obligated under the MOU. TAES shall not be obligated to continue performance under the MOU (including actions under the "Termination Procedures" provision) or otherwise

to incur costs in excess of the amount obligated under the MOU, unless and until IFDC has notified TAES in writing that such obligated amount has been increased and has specified the new MOU total amount.

2.6 Other Terms and Conditions

The following terms and conditions, which are applicable to the MOU by and between USAID and IFDC, shall be integral part of this Agreement.

2.6.1 Official Contacts

The contacts under this MOU for all official contacts are as follows:

IFDC Technical
Dr. Lawrence L. Hammond
Director, Research and Development Division
IFDC
PO Box 2040
Muscle Shoals, AL 35662, USA
Telephone: 256/381-6600, extension 270
FAX: 256/381-7408
lhammond@ifdc.org
www.ifdc.org

IFDC Business
Mr. John H. Allgood
Director, Finance, Administration, and Support Services
IFDC
PO Box 2040
Muscle Shoals, AL 35662, USA
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TAES Technical/Business
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PI Global Livestock CRSP-LEWS
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Texas A&M University
College Station, TX 77843-2126, USA
Telephone: 979/845-5548
Fax: 979/854-6430
jwstuth@cnrit.tamu.edu

2.6.2 Publications and Media Releases

If it is TAES's intention to identify USAID's contribution to any publication, video or other information/media product resulting from this MOU, TAES shall state that the views expressed by the author(s) do not necessarily reflect those of USAID. Acknowledgements should identify the sponsoring USAID Office and Bureau or Mission as well as USAID substantially as follows:

"This [publication, video or other information/media project (specific)] was made possible through support provided by the Center for Economic Growth and Agricultural Development, Office of Agriculture and Food Security, under the terms of the MOU. The opinions expressed herein are those of the author(s) and do not necessarily reflect the views of USAID."

TAES shall provide the relevant strategic objective or results package team with one copy of all published works developed under this MOU and with lists of other written work produced under the MOU.

Except as otherwise provided in the terms and conditions of the MOU, the author or TAES is free to copyright any books, publications, or other copyrightable materials developed in the course of or under this MOU, but USAID reserves a royalty-free nonexclusive and irrevocable right to reproduce, publish, or otherwise use, and to authorize others to use the work for U.S. Government purposes.

2.6.3 Reports and Data

TAES shall send to the IFDC Technical Contact at the address included in this MOU, monthly and quarterly progress reports in a form and substance satisfactory to IFDC. The monthly reports will provide a brief report on the status of activities being undertaken to implement this project during the previous 30 days.

The quarterly reports shall indicate progress toward achieving Program objectives and implementing approved work plans. The reports shall include, but not be limited to, the following information:

- Status of achievement of program goals, objectives, and benchmarks specified in the annual work plan
- Progress or completion of components, elements, or activities against planned targets
- Program description
- Other accomplishments or program highlights
- Identification and explanation of significant problems which have been encountered
- Description of planned corrective action

The monthly and quarterly reports may be submitted in electronic format and are to be delivered to IFDC within 7 calendar days and 20 calendar days, respectively, of the end of the reporting period. A final report addressing the same components included in the quarterly report is to be submitted to IFDC by TAES within 45 calendar days of the ending date of this MOU. The reports submitted to TAES to IFDC and supporting materials compiled in performing the services shall be the property of USAID.

TAES is also required to submit copies of reports/publications, produced within each activity as requested by the USAID Cognizant Technical Officer (e.g., workshop proceedings, PowerPoint presentations, etc.).

2.6.4 Termination

This agreement may be terminated, in whole or in part, by either party at any time upon 30 days written notice of termination. Upon receipt of and in accordance with a termination notice from the IFDC, the TAES shall take immediate action to cease all expenditures financed by this MOU and to cancel all unliquidated obligations if possible. Further, upon receipt of notice of termination, the TAES shall not enter into any further obligations under this MOU. Except as provided below, no further reimbursement shall be made after the effective date of termination. The TAES shall within 30 days of the effective date of termination repay to IFDC all unexpended funds that are not otherwise obligated by a legally binding transaction applicable to this MOU. Should the funds paid by IFDC to the TAES prior to the effective date of termination be insufficient to cover the TAES's obligations in a legally binding transaction, the TAES may submit to IFDC within 90 days after the effective date of termination a written claim for such amount. The IFDC shall determine the amount(s) to be paid by IFDC to the TAES under such claim in accordance with the "Allowable Costs" provision of this MOU.

2.6.5 Dispute Settlement

Any and all disputes, which may arise during the performance of this MOU, shall be settled through negotiations by and between the signatories to this MOU.

2.6.6 Investment Promotions

No funds or other support provided hereunder may be used in a program or activity reasonably likely to involve the relocation or expansion outside of the United States of an enterprise located in the United States if non-US production in

such relocation or expansion replaces some or all of the production of, and reduces the number of employees at, said enterprise in the United States.

No funds or other support provided hereunder may be used in a program or activity the purpose of which is the establishment or development in a foreign country of any export processing zone or designated area where the labor, environmental, tax, tariff, and safety laws of the country would not apply, without the prior written approval of IFDC.

No funds or other support provided hereunder may be used in an activity which contributes to the violation of internationally recognized rights of workers in the recipient country including those in any designated zone or area in that country. This provision must be included in all subagreements.

2.6.7 Non-Liability

IFDC does not assume liability for any third party claims for damages arising out of this MOU.

2.6.8 Notices

Any notice given by either party under this MOU shall be sufficient only if in writing and delivered in person or faxed to the official contact persons identified in 2.5.1

2.6.9 Special Provisions

TAES shall comply with USAID environmental regulations (22 CFR Section 216 "Regulation 16") with respect to the activities to be undertaken under this MOU.

2.6.10 Procurement Policies and Procedures

Because USAID is the sole contributor, USAID procurement policies and procedures are applicable (22 CFR Section 226 and ADS 3[illegible]8.5.7a).

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2.6.11 Ineligible Countries

Activities under this agreement may only be carried out in countries that are eligible to receive assistance under the Foreign Assistance Act. TAES shall provide IFDC in advance a list of those countries where activities are planned under this MOU.

2.6.12 Entire MOU

Unless otherwise specified, this MOU embodies the entire understanding between IFDC and TAES for the services to be provided and any prior to contemporaneous representations, either oral or written, are hereby superseded. No amendments or changes to this MOU, including, without limitation, changes in the statement of work, total estimated cost, and period of performance, shall be effective unless made in writing and signed by authorized representatives of the parties.

FOR AND ON BEHALF OF IFDC

By: _____

Name: JOHN H. ALLGOOD

Title: DIRECTOR, FINANCE & ADMIN

Date: NOV 5, 2001

FOR AND ON BEHALF OF TAES

By: _____ 11.28.01

Name: Charles J. Seifres

Title: Deputy Director

Date: _____

WITNESS:

By: _____

Name: LAWRENCE HAMMOND

Title: Director, R&D

Date: 5 NOV 2001

WITNESS:

By: _____

Name: Diane Gilland

Title: Asst Director for Research Admin

Date: 11-27-01

B. Target Region 2 - African Great Lakes Region:

LEWS Project – Texas A & M with GL (Global Livestock CRSP)

PROPOSAL

Multi-Scale Aggregation of Biophysical Processes Affecting Pastoral Communities In East Africa

SUBMITTED TO

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BY

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GL-CRSP-LEWS WORKPLAN for GISD-WSSD SPATIAL CASE STUDY

Jerry W. Stuth
PI – Global Livestock CRSP – Livestock Early Warning System (LEWS)
Texas A&M University

TITLE:

Multi-Scale Aggregation of Biophysical Processes Affecting Pastoral Communities In East Africa

IV. BACKGROUND:

One of the goals of the *Geographic Information for Sustainable Development (GISD)* plan of action is to apply a new generation of earth observation data and state of the art GIS-linked technologies to allow sustainable development to be measured, monitored and integrated into decision-making at all scales by users themselves—from local to national and even global scales. The Livestock Early Warning Systems project (http://cnrit.tamu.edu/lews) in the Global Livestock CRSP offers a unique case study for presentation at the World Summit for Sustainable Development that demonstrates the application of integrated remotely sensed weather data, point-based biophysical modeling, and spatially stratified animal and vegetation data to serve multiple-scale decision makers concerned with the welfare of pastoral communities in East Africa.

There are currently, six operational monitoring zones in East Africa (Southern Ethiopia, Northern Kenya, Southern Kenya, Central/Southwest Uganda, Northern Tanzania and Central Tanzania). Two other zones are under development in the Afar region of Northeast Ethiopia and Northeast Uganda. Each zone is comprised of 30 carefully selected monitoring points from a spatial stratification based on climatic cluster analysis, rural human density, and livestock density. The vegetation at each point is characterized in a format compatible for the PHYGROW rangeland model (grass basal cover, forb frequency and woody effective canopy cover) as well as typical soils descriptions and pastoral stocking/movement rules. These geo-referenced points are linked to an online African-wide weather database (http://cnrit.tamu.edu/rsg/rainfall/rainfall.cgi) which is acquired by LEWS from daily METEOSAT weather data generated by NOAA in collaboration with FEWS-NET. Each site's modal plant community parameterization file, GPS coordinates and associated METEOSAT weather grid are managed by an automated data acquisition, analysis and mapping system. Data of forage conditions generated for each site can be viewed at http://cnrit.tamu.edu/aflews household portal. A first generation krig/co-krigged map is now being put up at one of the sites which is using point information on forage conditions co-krigged with FEWS-NET AVHRR NDVI 8x8 km data. The automated system acquires the weather and NDVI data every 10 days and updates the site in an unsupervised manner. A small file size of the model output dataset is packaged every ten days for broadcasting to teams in the zone equipped with WorldSpace Satellite radios linked to laptop computers. The reduced LEWS data is managed by the ASARECA Crisis Mitigation Office in Nairobi and distributed on the African Learning Channel via containers provided by the Arid Lands Information Network. To address livestock issues directly, we are establishing a network of households in each zone that provide monthly fecal samples from cattle, sheep and goats, which are shipped to a NIRS lab established in each country by LEWS. NIRS scans of the feces provide estimates of diet protein and energy of free-ranging animals. Diet quality information is linked with the NUTBAL PRO nutritional balance analyzer decision support system to predict animal weight change and body condition. The animal monitoring system to date has been delayed due to the slow process of establishing a lab in each country, each year. The lab development process will be completed in December but Kenya is fully functional now.

Over the past 2 years LEWS has developed a strong, integrated working relationship with ASARECA's Crisis Mitigation Office. In the past 5 months, stronger partnerships have been cultivated with IGAD's Drought Monitoring Center (DMC) and the Regional Center for Mapping Resource Developments (RCMRD). LEWS is currently in the process of improving computer server capacity at these three institutions and providing training in use of ARCVIEW at DMC. LEWS is also placing analytical capacity at ASARECA CMO and RCMRD to help institutionalize the regional computing capacity of those organizations to better serve East Africa. Texas A&M University's Center for Natural Resource Information Technology (CNRIT) has dedicated staffing and server

capacity to insure that the automation processing can continue indefinitely to support the system as well. Currently, LEWS, based at Texas A&M University, provides the analytical computing capacity for the system.

V. TARGETED USE OF ADDITIONAL FUNDS

In order for the LEWS program to develop a robust case study for the WSSD conference in September 2002, funds will be targeted for the zones in Southern and Northern Kenya with cross border linkages to Southern Ethiopia and Northern Tanzania. The following activities in this region will be augmented with these funds:

Linking Zones in Regional Spatial Analysis

Currently, LEWS has established geo-statistical analysis in Southern Kenya and is in the process of finalizing geo-statistical analysis for Northern Kenya. In order to link these zones into a more regional perspective, some of the funds will be allocated to cover costs of our teams in Kenya to add monitoring points outside of the current zones that allow more robust kriging and co-kriging of regional spatial analyses. This will mean that some points will have to be added between the Southern Ethiopia Zone and Northern Kenya and between Northern Tanzania and Southern Kenya.

Accelerating Fecal Monitoring System

The households in Southern and Northern Kenya have been established but we have been short on funds to stabilize the monthly monitoring system for the 15 households in each zone. Some of the requested funds would be used to firm up the sampling protocol and stabilize the personnel/transport infrastructure in each of the two zones to allow rapid turn around time on collection of feces, prediction of diets and running the regional analysis for NUTBAL PRO. To support this activity, LEWS at TAMU would work with NOAA's FEWS-NET rep, Mr. Tim Love, to automate acquisition of Min/Max temperature, wind and relative humidity data in a format that is compatible with an automated animal performance system using NUTBAL PRO as a parallel analysis system to the automated vegetation modeling system. LEWS funds would be used for this activity to produce the maps of projected animal performance as a product for demonstration purposes at WSSD. However, some requested funds would be used to improve communications between the zonal teams and LEWS established NIRS lab at KARI Naivasha Research Center in Kenya. Mapping of animal performance has never been done before and this would be a significant contribution to the process.

VI. Fostering Multiple Scale Communications to Decision Makers

Currently, we are working on establishing WorldSpace Satellite Radio linked to computers (offline) in key ministry offices, DMC and NGO's active in the targeted zones that write reports for key decision makers at the national and regional scale. Some of these funds would be used to purchase the satellite radios to place in the key communication nodes within the LEWS network in the region. Training of personnel in these organizations in use of the radios and interpretation of the LEWS reports will be the primary focus of use of these funds in this activity set.

Community outreach to pastoralists will be fostered with the funds by augmenting current PRA activities underway in both the Northern and Southern Zones. We will hire a short-term Kenyan PRA specialist to assist in testing early warning communication techniques in selected pastoral villages within these two zones. One of the constraints to this process has been limited training by our NAR counterparts in the LEWS zone in PRA techniques and community outreach activities with pastoralists. This activity would help establish capacity within LEWS to more effectively develop information delivery systems that impact decision making at the local level. DMC an RCMRD have also identified this area as a major concern in communicating early warning products to rural people and will work with LEWS to gain more insights into the process.

Capacity Building in DMC and RCMRD

LEWS has already established a working relationship with DMC and RCMRD. Some of the funds would be used to offset training costs of involving staff from these two institutions in the application of geo-statistical extrapolation of point-based modeling to project biophysical responses across larger areas. Also, funds would be allocated to jointly train DMC and RCMRD staff with our LEWS teams in pastoral communication issues for early warning systems as mentioned previously.

VII. BUDGET

Item		Cost
Spatial Integration of Zones		$ 7,000
Accelerating Fecal Monitoring System	$18,000	
Communication Enhancement	$15,000	
Capacity Building at DMC/RCMRD		$ 5,000
Total		$45,000 **

Item		Linking Zones w/new Points	Accelerating Fecal Profiling	Multiple Scale Communications	DMC/RCMRD Capacity Building	Total
Salary		$0	$0	$0	$0	$0
Wages		$2,000	$8,000	$3,000	$0	$13,000
Fringe Benefits		$0	$0	$0	$0	$0
	Salary Subtotal	$2,000	$8,000	$3,000	$0	$13,000
Travel						
	International	$500	$0	$1,600	$0	$2,100
	Domestic	$3,000	$6,400	$3,000	$0	$12,400
	Travel Subtotal	$3,500	$6,400	$4,600	$0	$14,500
Materials, Supplies, Repairs		$865	$1,965	$1,000	$0	$3,830
Equipment		$0	$0	$2,035	$0	$2,035
Training		$0	$0	$3,000	$4,545	$7,545
	Subtotal	$6,365	$16,365	$13,635	$4,545	$40,910
Indirect Costs 10%		$635	$1,637	$1,364	$455	$4,090
	Total	**$7,000**	**$18,002**	**$14,999**	**$5,000**	**$45,000**

** These funds should be run through University of California at Davis, Office of the Global Livestock CRSP, base grant (PCE-G-00-98-00036-00) which will issue a modification of the current Texas A&M University - Texas Agricultural Experiment Station subgrant for the Livestock Early Warning Systems program.

(Final budget is dependent on contractual arrangements, e.g. transfer to an existing Cooperative Agreement between USAID/AFS and the Global Livestock CRSP)

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KEY CONTACTS:

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UC-Davis – Global Livestock CRSP Office (Primary Fiscal Officer)
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GISD-WSSD SPATIAL CASE STUDY
Final Report
December 31, 2002

Multi-Scale Aggregation of Biophysical Processes Affecting Pastoral Communities In East Africa

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Submitted to:

Lawrence L. Hammond
Director, Resource Development Division
IFDC
P.O. Box 2040
Muscle Shoals, AL 35662

1. Status of achieving program goals, objectives and benchmarks specified in the annual work plan

Four major activity areas were identified to embellish on going efforts in the USAID Global Livestock CRSP project on development of a Livestock Early Warning System for East Africa. In order for the LEWS program to develop a robust case study for the WSSD conference in late August 2002, funds were targeted for the zones in Southern and Northern Kenya with cross border linkages to Southern Ethiopia and Northern Tanzania. The following activities in this region were the focus of this program enhancement:

1. Spatial Integration of Zones
2. Accelerating Fecal Monitoring System
3. Communication Enhancement
4. Capacity Building at DMC/RCMRD

All activities are on schedule to meet the target products to augment the spatial analysis activities within the LEWS/GLCRSP program for presentation at the World Summit on Sustainable Development in late August.

2. Progress or completion of components, elements or activities, against planned targets

Linking Zones in Regional Spatial Analysis

Currently, LEWS has established geo-statistical analysis in Southern Kenya and is in the process of finalizing geo-statistical analysis for Northern Kenya. In order to link these zones into a more regional perspective, additional monitoring sites were established outside of the current zones that allow more robust kriging and co-kriging of regional spatial analyses. The LEWS teams went to Northeastern and Eastern Kenya and established 30 monitoring points. This activity involved specifying the soil attributes by layer, measuring the basal area of grasses, frequency of forbs and effective canopy cover of woody plants. The data has been input into the PHYGROW model and output stabilized. Eight additional monitoring points have been field characterized and input into PHYGROW for the Baringo district of Kenya. Currently, a team went into the Somali region of central-eastern Ethiopia and established monitoring sites in collaboration with Save the Children – UK and Hope for the Horn to help improve our geo-statistical projections for the entire region.

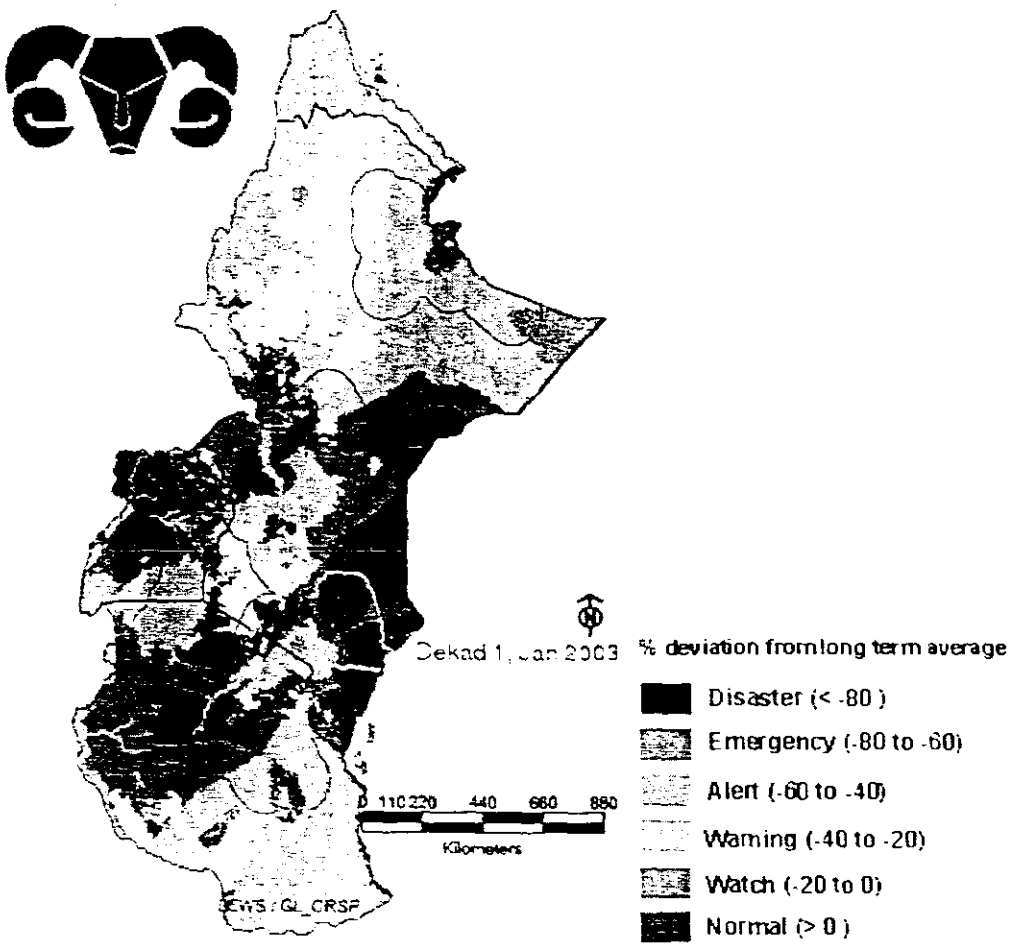

Figure 1. Example of new co-krigged regional map indicating regions of dangerously low forage supply. The added points in eastern Kenya and Ethiopia improved the projections in the target region of the ASSD case study.

Accelerating Fecal Monitoring System

We completed modification of our software that generates the weather data for the forage production models to acquire added information on wind and humidity for the entire study region. Automation of the NUTBAL PRO modeling environment linked to the weather data is complete for use of the system over the internet system (http://cnrit.tamu.edu/autosystem).

Data collection has been completed on the forage quality mapping and we are in the process of developing co-kriging of forage quality in two test sites in Southwestern Uganda and Southern Kenya (Figure 2).

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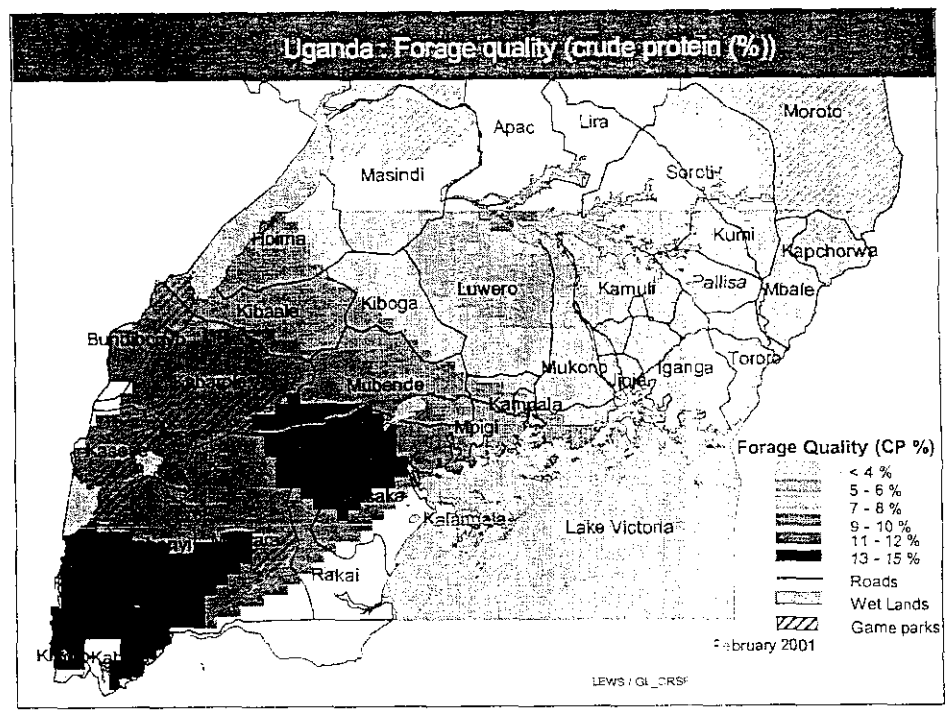

Figure 2. Map of dietary crude protein of cattle in Southwestern Uganda (8x8 km grid resolution) using georeferenced fecal samples cokriged with NDVI greenness data.

Fostering Multiple Scale Communications to Decision Makers

Arid Lands Information Network has established 10 satellite radio nodes and trained them in use of our reports. The LEWS teams have deployed an added 19 satellite radio nodes linked with computers at key NGO, NAR and extension offices around the region. A email link was created at the Ministry of Agriculture to insure that all LEWS reports are sent to extension offices via regular mail after receiving them in Nairobi via the internet.

We completed the first two additions of the Greater Horn of Africa Early Warning Bulletins with FEWS NET, RCMRD, USGS and DMC. The bulletins can be view at http://cnrit.tamu.edu/aflews/bulletins.cgi?type=GHA . Our forage condition maps and interpretative reports go out once a month in this important newsletter.

Capacity Building in DMC and RCMRD

Training has been provided to DMC staff in the kriging and co-kriging process used in LEWS. ARCGIS 8.1 has been purchased with TAMU providing site licenses to the Regional Center for Mapping Resource Development. A preliminary training has been provided on the ARCVIEW component with more advanced training planned for June.

3. Description of the overall program

One of the goals of the *Geographic Information for Sustainable Development (GISD)* plan of action is to apply a new generation of earth observation data and state of the art GIS-linked technologies to allow sustainable development to be measured, monitored and integrated into decision-making at all scales by users themselves—from local to national and even global scales. The Livestock Early Warning Systems project (http://cnrit.tamu.edu/lews) in the Global Livestock CRSP offers a unique case study for presentation at the World Summit for Sustainable Development that demonstrates the application of integrated remotely sensed weather data, point-based biophysical modeling, and spatially stratified animal and vegetation data to serve multiple-scale decision makers concerned with the welfare of pastoral communities in East Africa.

At the start of this project, six operational monitoring zones were in operation in East Africa (Southern Ethiopia, Northern Kenya, Southern Kenya, Southwest Uganda, Northern Tanzania and Central Tanzania). We developed Three other zones are under development in the Afar and Somali region of Northeast Ethiopia, and Northeastern Kenya.. Each zone is comprised of 30 carefully selected monitoring points from a spatial stratification based on climatic cluster analysis, rural human density, and livestock density. The vegetation at each point is characterized in a format compatible for the PHYGROW rangeland model (grass basal cover, forb frequency and woody effective canopy cover) as well as typical soils descriptions and pastoral stocking movement rules. These geo-referenced points are linked to an online African-wide weather database (http://cnrit.tamu.edu/rsg/rainfall/rainfall.cgi) which is acquired by LEWS from daily METEOSAT weather data generated by NOAA in collaboration with FEWS-NET. Each site's modal plant community parameterization file, GPS coordinates and associated METEOSAT weather grid are managed by an automated data acquisition, analysis and mapping system. Data of forage conditions generated for each site can be viewed at http://cnrit.tamu.edu/aflews household portal. A first generation krig co-krigged map is now being put up at one of the sites which is using point information on forage conditions co-krigged with FEWS-NET AVHRR NDVI 8x8 km data. The automation system acquires the weather and NDVI data every 10 days and updates the site in an unsupervised manner. A small file size dataset is also packaged every ten days for broadcasting to teams in the zone equipped with WorldSpace Satellite radios linked to laptop computers. The reduced LEWS data is managed by the ASARECA Crisis Mitigation Office in Nairobi and distributed on the African Learning Channel via containers provided by the Arid Lands Information Network. To address livestock issues directly, we are establishing a network of households in each zone that provide monthly fecal samples from cattle, sheep and goats which are shipped to a NIRS lab established in each country by LEWS. NIRS fecal scans of the feces provide estimates of diet protein and energy of free-ranging animals. When the diet quality information is linked with the NUTBAL PRO nutritional balance analyzer decision support system, it is possible to predict animal weight change and body condition. The animal monitoring system to date has been delayed due to the slow process of establishing a lab in each

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country, each year. The lab development process will be complete in December but Kenya is fully functional now.

Over the past 2 years LEWS has developed a strong, integrated working relationship with ASARECA's Crisis Mitigation Office. In the past 5 months, stronger partnerships have been cultivated with IGAD's Drought Monitoring Center (DMC) and the Regional Center for Mapping Resource Developments (RCMRD). LEWS is currently in the process of improving computer server capacity at these three institutions and providing training in use of ARCVIEW at DMC. LEWS is also placing analytical capacity at ASARECA CMO and RCMRD to help institutionalize the regional computing capacity of those organizations to better serve East Africa. Texas A&M University's Center for Natural Resource Information Technology (CNRIT) has dedicated staffing and server capacity to insure that the automation processing can continue indefinitely to support the system as well. Currently, LEWS based at Texas A&M University provides the analytical computing capacity for the system.

4. Other accomplishments and major highlights of program implementation

In parallel to this process, LEWS has hired a Kenyan graduate student, Laban MacOpiyo beginning January 15, 2002 to start assembling spatial data on pastoral livestock production systems and marketing systems. The ultimate goal is to create a spatial analysis framework for understanding livestock marketing dynamics across East Africa. This exercise has emerged a network of GIS people with a diverse set of GIS datasets on a wide array of disjointed sources. This will be the first complete compilation of GIS data to better serve pastoral issues in the region. FAO has requested that we submit a proposal to add monitoring sites in Somalia because of these efforts.

A new projection routine was developed that allows us now to provide information on where at local site is currently in relation to long term normal forage conditions, where they were at the same time last year and what the next 90 days will likely do with an above normal, normal and below normal weather projection based on a population of 22 years CHARM rainfall data (http://cnrit.tamu.edu/charm) coupled with generated temperature data that is surface corrected for each of the 300+ monitoring points in the region. Using a new ARIMA time series forecasting method which co-regresses historical NDVI data and corresponding model output of weather data, we have perfected a mechanism to forecast most likely conditions up to 90 days from current conditions and update the forecast every 10 days (Figure 3). A project map is then developed of future forage supply (see the AFLEWS site at http://cnrit.tamu.edu/aflews) to view these maps

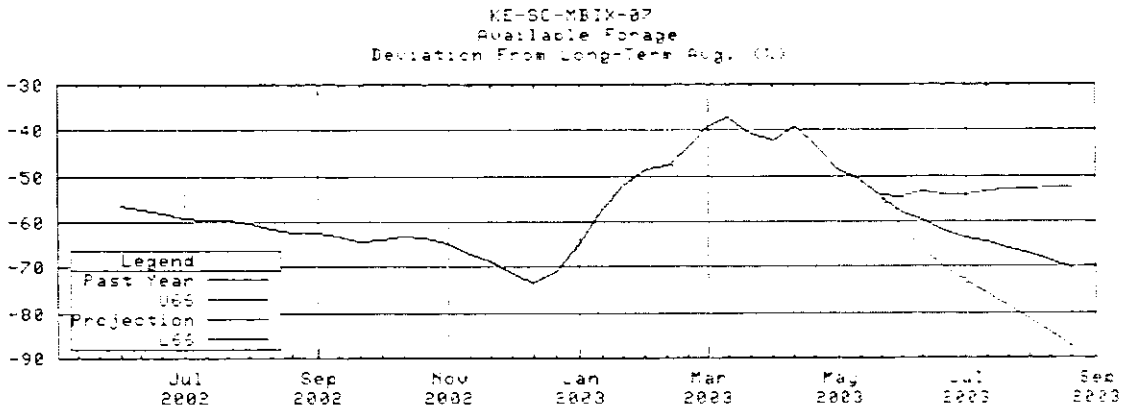

Figure 2. Example output from one of the more hard hit sites in Southern Kenya. The blue line represents the most likely trend with upper and lower boundary which defines 66% confidence limits.

5. Identification and explanation of significant problems or delays related to achievement of objectives or activities

There are no significant problems interfering with targeted activities.

6. A brief summary of significant corrective actions and major activities planned for the future.

Because of the NGOs on the ground have seen the benefit of the geostatistical mapping we have developed in LEWS, the NAR's in each country are now seeing the need for good data across their borders to improve the predictions in their own countries. We are currently starting a pastoral survey on perception of drought relative to the modeled predictions of forage deviation to assist in preparation outreach programs on understanding the implications of the LEWS projections. This survey is to be completed by July 1, 2003. Each zonal coordinator is currently canvassing NGO's operating in their zones to determine which one would benefit from being a LEWS communication node with a worldspace satellite radio. Once these NGOs are identified, we will expand training in use of the radios and interpretation of the LEWS output in each location.

BEST AVAILABLE

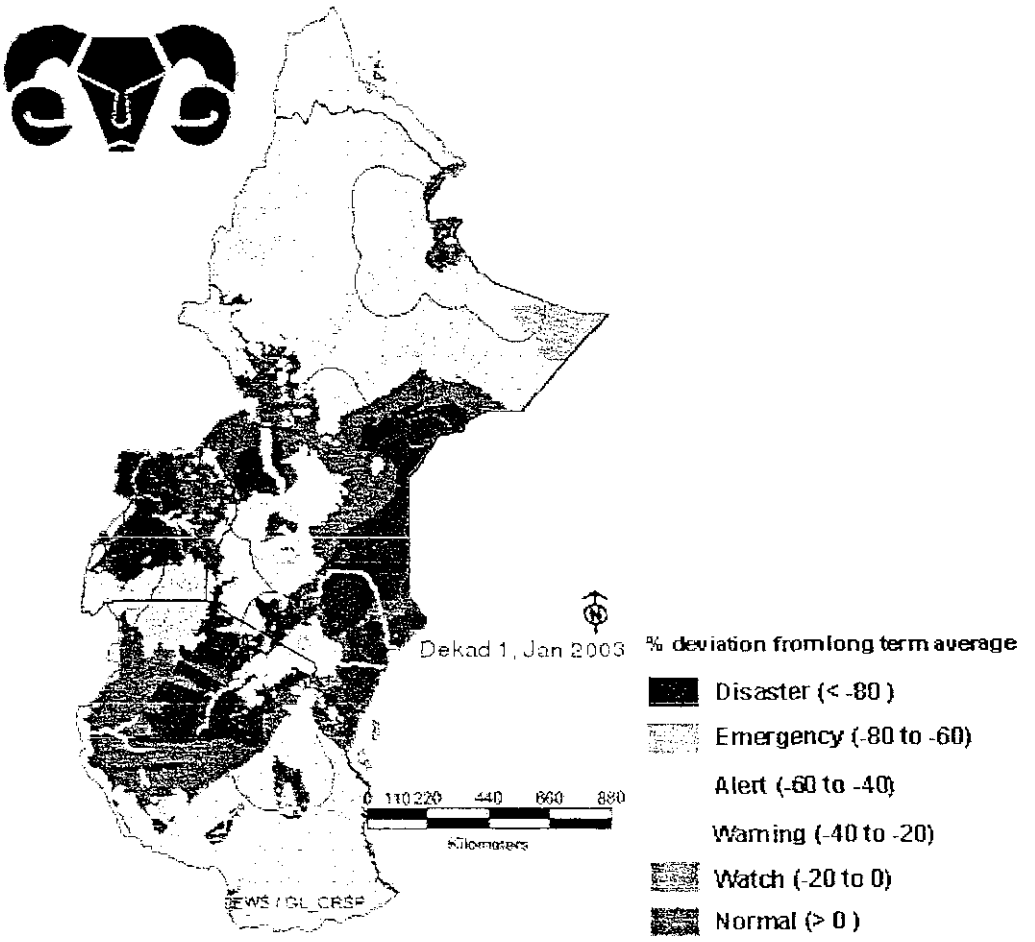

Figure 1. Example of new co-krigged regional map indicating regions of dangerously low forage supply. The added points in eastern Kenya and Ethiopia improved the projections in the target region of the WSSD case study.

Accelerating Fecal Monitoring System

We completed modification of our software that generates the weather data for the forage production models to acquire added information on wind and humidity for the entire study region. Automation of the NUTBAL PRO modeling environment linked to the weather data is complete for use of the system over the internet system (http://cnrit.tamu.edu/autosystem).

Data collection has been completed on the forage quality mapping and we are in the process of developing co-kriging of forage quality in two test sites in Southwestern Uganda and Southern Kenya (Figure 2).

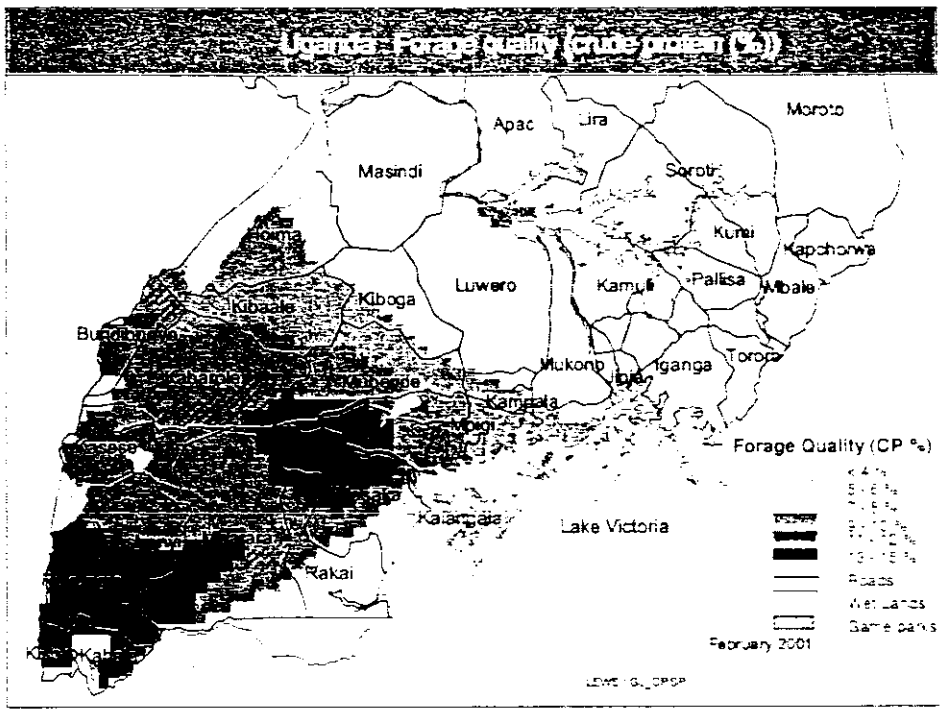

Figure 2. Map of dietary crude protein of cattle in Southwestern Uganda - 5x5 km grid resolution using georeferenced fecal samples cokriged with NDVI greenness data.

Fostering Multiple Scale Communications to Decision Makers

Arid Lands Information Network has established 10 satellite radio nodes and trained them in use of our reports. The LEWS teams have deployed an added 19 satellite radio nodes linked with computers at key NGO, NAR and extension offices around the region. A email link was created at the Ministry of Agriculture to insure that all LEWS reports are sent to extension offices via regular mail after receiving them in Nairobi via the internet.

We completed the first two additions of the Greater Horn of Africa Early Warning Bulletins with FEWS NET, RCMRD, USGS and DMC. The bulletins can be view at http://cnrit.tamu.edu/aflews/bulletins.cgi?type=GHA . Our forage condition maps and interpretative reports go out once a month in this important newsletter.

Capacity Building in DMC and RCMRD

Training has been provided to DMC staff in the kriging and co-kriging process used in LEWS. ARCGIS 8.1 has been purchased with TAMU providing site licenses to the Regional Center for Mapping Resource Development. A preliminary training has been provided on the ARCVIEW component with more advanced training planned for June

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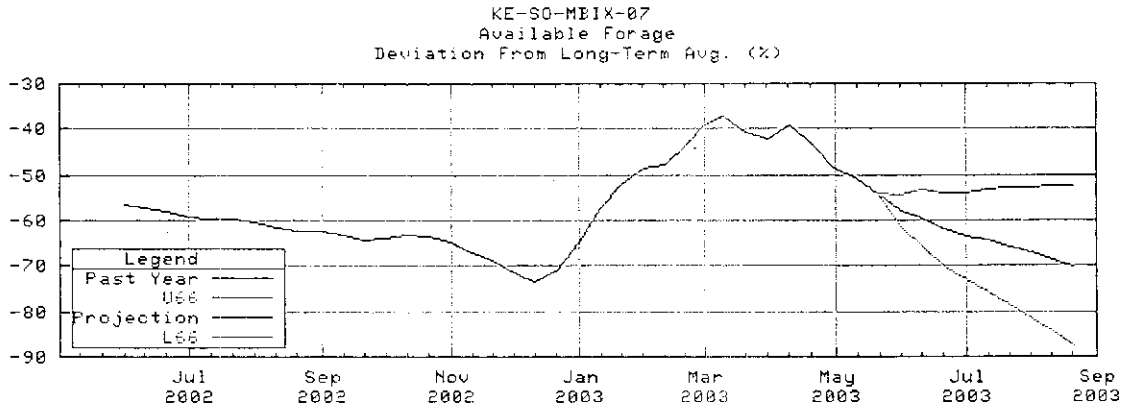

Figure 2. Example output from one of the more hard hit sites in Southern Kenya. The blue line represents the most likely trend with upper and lower boundary which defines 66% confidence limits.

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GISD Project
Annex 6

Subcontract With
National Research Council
IFDC Contract # 01598/02

1. Project Summary Page
2. Project Memorandum of Understanding
3. Project Final Report

	Project Summary Page
MOU Lead Implementation Organization	**National Research Council (NRC)**
Contact Person	Ms. Lisa Vandemark Staff Officer of the Board on Earth Sciences' Committee on Geography National Research Council 2101 Constitution Avenue, NW Washington, DC 20418, USA Telephone: 202/334-2744 Fax: 202/334-1377 lvandema@nas.edu
Project/Program and Statement of Work	Target Region 5: Africa-Wide Capacity Building & Synthesis Projects: **NRC Synthesis Study** The Geographic Foundation for Agenda 21. The NRC will examine (1) existing remote-sensing and GIS efforts in case-study regions, and lessons learned from those efforts, (2) existing levels of local expertise and technology, and ongoing efforts in geospatial capacity building, (3) a range of questions relating to the practical application of new and existing spatial data (e.g., required resolution, challenges of integrating layers of environmental and social data, and baseline data against which future change can be measured), (4) the role of decision support systems in the application of these data, and (5) options for making efforts sustainable beyond 2002. A description of the activities to be undertaken by OGC, technical procedures to be followed, deliverables required, and estimated schedule are presented in Attachment 1. Attachment 1 is incorporated as an integral part of this Memorandum of Understanding (MOU).
Collaborating Institutions	
IFDC Contract Number	01598/02
Budget Amount	Signed contract with NAS for $75,000 on December 3, 2001
Amendment(s)	
Extension Ending Date	

2.0 SPECIFIC CONDITIONS

2.1 Effective Dates of MOU

The effective dates of this MOU are upon bilateral signature of the NAS and IFDC and shall end on September 30, 2002.

2.2 Finance

The study to be performed by the NAS under this MOU is being financed in part by USAID under this MOU. IFDC shall provide funding to NAS in accordance with the terms and conditions described in this MOU. The estimated funds available to NAS total US $75,000 (seventy-five thousand) as follows:

Item	Total US $
Direct Labor	18,388
Travel	25,217
Reporting	4,919
Technology Commercial	1,977
Meeting Expense	729
Other direct	895
Overhead	10,598
Subtotal	**62,714**
G& A	12,286
TOTAL	**75,000**

2.2.1 Use of Funds

IFDC has fiduciary responsibility of funds received from USAID. Under the terms of this MOU, USAID/IFDC funds provided to NAS shall be utilized solely for the purposes indicated in the NAS proposal and budget under 2.2. Said funds shall partially cover all expenditures necessary for the study to be performed by NAS. IFDC shall not be responsible for any additional costs (i.e., above US $75,000) incurred in the performance of the work described under this MOU.

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2.2.2 Allowable Costs

Funds provided under this MOU shall be used for allowable costs in accordance with OMB Circular A-122 and the provisions of this MOU.

2.2.3 Payments

IFDC shall make payments to NAS subject to the receipt of funds from USAID and based upon receipt of an official invoice from NAS. The invoice may be faxed to the official IFDC Business Contact indicated in 2.6.1. The payments shall be made on a reimbursable basis in accordance with the NAS's standard billing format (SF 1034/1035) and based upon NAS'S submission of financial reports, which substantiate costs incurred in the performance of this MOU.

2.2.4 Financial Reports

NAS shall provide to IFDC, within 20 days of the end of each quarter under this program, a financial report indicating funds received from IFDC and funds expended under this MOU. The financial reports shall include accounting for all allowable costs incurred by NAS under the program and be in accordance with the line item budget amounts indicated in 2.2. Subject to receipt of a written request by USAID, NAS will provide to IFDC/USAID documentation to support costs incurred under this MOU.

IFDC INTERNATIONAL FERTILIZER DEVELOPMENT CENTER • MUSCLE SHOALS, ALABAMA 35662 USA
P.O. BOX 2040 • 256-381-6600
EMAIL-general@IFDC.org
TELEFAX NO. 256-381-7408

Memorandum of Understanding

Between

International Fertilizer Development Center
PO Box 2040
Muscle Shoals, AL 35662, USA

And
National Academy of Sciences
2101 Constitution Avenue, NW
Washington, DC 20418, USA

The International Fertilizer Development Center (hereinafter referred to as IFDC) is a public international organization (PIO) dedicated to increasing sustainable agricultural production through the improved use of yield enhancing technologies. The National Academy of Sciences (NAS) has submitted proposal number 01-DELS-208-04 to USAID to partially fund the conduct a study and develop a report on "The Geographic Foundation for Agenda 21." In order to carryout the work described herein, IFDC and NAS hereby agree to the following terms and conditions:

1.0 INTRODUCTION AND STATEMENT OF WORK

The United States Agency for International Development (USAID) has entered into an Agreement with IFDC for IFDC to undertake a project entitled "Quick Start for Agriculture in Africa" to support the Geographic Information for Sustainable Development (GISD) project leading up to the World Summit on Sustainable Development (WSSD).

IFDC will provide USAID/EGAD/AFS with logistical and management support to the various partners involved in the implementation of the GISD project, including transferring and providing overall fiscal oversight to specific "pass-through" funds to selected partners who are being asked to implement specific GISD activities. This will include work already identified in specific proposals from the NAS, NAS, and several other groups located in the four Target

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Regions: Upper Niger Basin, African Great Lakes Region, the Kenya-Tanzania Coastal Zone, and the Limpopo/Zambeze River Basin Region of southern Africa.

IFDC will work in close collaboration with the technical officers within USAID providing oversight: Note: The Overall Coordinator is Robert E. Ford, AEMD – Agricultural Enterprise and Market Development Division within USAID's office of Agriculture and Food Security. Robert E. Ford is the Chair of the GISD-IWG for Regional Applications sub-group. The nature of the oversight and collaborative activities of IFDC under this MOU shall be primarily administrative. Such activities are intended to ensure that logistics, communications and related support are provided in an efficient and timely manner to USAID and recipients of funds under the USAID GISD-WSSD project.

Close coordination must also occur with co-Chairs of the GISD-IWG for each sub-region. They are: Barbara Best (G/ENV) for the Kenya-Tanzania CZM Activity; Paul Bartel and Jon Anderson (AFR-SD) for the Four Corners/Limpopo/Zambezi Basin region; Robert Ford for the Great Lakes/Great Horn of Africa Region; and Mike McGahuey (USAID/AFR-SD).

The NAS will examine (1) existing remote-sensing and GIS efforts in case-study regions, and lessons learned from those efforts, (2) existing levels of local expertise and technology, and ongoing efforts in geospatial capacity building, (3) a range of questions relating to the practical application of new and existing spatial data (e.g., required resolution, challenges of integrating layers of environmental and social data, and baseline data against which future change can be measured), (4) the role of decision support systems in the application of these data, and (5) options for making efforts sustainable beyond 2002. A description of the activities to be undertaken by NAS, technical procedures to be followed, deliverables required, and estimated schedule are presented in Attachment 1, which is incorporated as an integral part of this Memorandum of Understanding (MOU).

IFDC01598 02

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And

National Academy of Sciences
2101 Constitution Avenue, NW
Washington, DC 20418, USA

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2.2.5 Audit

NAS shall maintain books, records, documents, and other evidence in accordance with NAS's usual accounting procedures to sufficiently substantiate charges to this MOU. IFDC and USAID reserve the right to examine and NAS agrees to make available on site at the NAS all financial records and supporting financial non-privileged documents of the NAS as related to this MOU. Any costs that are determined by either IFDC or USAID to be inconsistent with the terms and conditions of this MOU shall immediately be refunded to IFDC. As a result of the level of federal funds received by NAS, NAS does undergo audits conducted in accordance with OMB Circular A-133. UPON request by USAID IFDC, NAS shall submit to IFDC a copy of the OMB A-133 audit(s) completed for fiscal year(s) within which USAID IFDC provides funds to NAS under this MOU.

2.2.6 Refunds

(a) Funds not disbursed to NAS at the time the MOU expires or is terminated shall revert to IFDC, except reasonable costs necessary to close down the activity and for such funds encumbered by NAS by a legally binding transaction applicable to this MOU.

(b) If, at any time during the life of the MOU, or as a result of final audit, it is determined that funds provided under this MOU have been expended for purposes not in accordance with the terms of this MOU, NAS shall refund such amount to IFDC.

2.3 Subagreements

It is understood that NAS does not intend to employ sub-agreements in the conduct of the study under this MOU. However, should this situation change, NAS may carry out the work described under this MOU in collaboration with others. Funds provided to NAS may be used to support work carried out by collaborating institutions. NAS shall ensure that the specific conditions of this MOU (i.e., Section 2.0, Specific Conditions) shall apply to any such subagreements.

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2.4 Revision of MOU Budget

(a) The approved MOU budget is the financial expression of NAS's program.

(b) NAS shall immediately request approval from IFDC when there is reason to believe that within the next 30 calendar days a revision of the approved MOU budget will be necessary for any of the following reasons:

- To change the scope or the objectives of the program and/or revise the funding allocated to line items by more than ten percent of the total budget amount.
- Additional funding is needed.
- NAS expects the amount of authorized funds to exceed its needs by more than $5,000 or five percent of the MOU budget, whichever is greater.

(c) Except as required by other provisions of this MOU specifically stated to be an exception from this provision, IFDC shall not be obligated to reimburse NAS for costs incurred in excess of the total amount obligated under the MOU. NAS shall not be obligated to continue performance under the MOU (including actions under the "Termination Procedures" provision) or otherwise to incur costs in excess of the amount obligated under the MOU, unless and until IFDC has notified NAS in writing that such obligated amount has been increased and has specified the new MOU total amount.

2.5 Other Terms and Conditions

The following terms and conditions, which are applicable to the MOU by and between USAID and IFDC, shall be integral part of this Agreement.

2.5.1 Official Contacts

The contacts under this MOU for all official contacts are as follows:

IFDC Technical
Dr. Lawrence L. Hammond
Director, Research and Development Division
IFDC
PO Box 2040
Muscle Shoals, AL 35662, USA
Telephone: 256/381-6600, extension 270
FAX: 256/381-7408
lhammond@ifdc.org
www.ifdc.org

IFDC Business
Mr. John H. Allgood
Director, Finance, Administration, and Support Services
IFDC
PO Box 2040
Muscle Shoals, AL 35662, USA
Telephone: 256/381-6600, extension 211
FAX: 256/381-7408
jallgood@ifdc.org
www.ifdc.org

NAS Technical
Ms. Lisa Vandemark
Staff Officer of the Board on Earth Sciences' Committee on Geography
National Academy of Sciences
2101 Constitution Avenue, NW
Washington, DC 20418
Telephone: 202/334-2744
Fax: 202/334-1377
lvandema@nas.edu

NAS Business Contact
Mr. Douglas E. Denning
Contract Manager
National Academy of Sciences
Office of Contracts and Grants
2101 Constitution Ave., NW, Suite GR 406
Washington, DC 20418
Telephone 202/334-3377
Fax: 202/334-2797
ddenning@nas.edu

2.5.2 Publications and Media Releases

If it is NAS's intention to identify USAID's contribution to any publication, video or other information/media product resulting from this MOU, NAS shall state that the views expressed by the author(s) do not necessarily reflect those of USAID. Acknowledgements should identify the sponsoring USAID Office and Bureau or Mission as well as USAID substantially as follows:

"This [publication, video or other information/media project (specific)] was made possible through support provided by the Center for Economic Growth and Agricultural Development, Office of Agriculture and Food Security, under the terms of the MOU. The opinions expressed herein are those of the author(s) and do not necessarily reflect the views of USAID."

NAS shall provide to the designated representative (Dr. Robert Ford) of the relevant strategic objective or results package team one copy of all published works developed under this MOU and with lists of other written work produced under the MOU.

Except as otherwise provided in the terms and conditions of the MOU, the author or NAS is free to copyright any books, publications, or other copyrightable materials developed in the course of or under this MOU, but USAID reserves a royalty-free nonexclusive and irrevocable right to reproduce, publish, or otherwise use, and to authorize others to use the work for U.S. Government purposes.

2.5.3 Reports and Data

NAS shall send to the IFDC Technical Contact at the address included in this MOU, monthly and quarterly technical progress reports in a form and substance satisfactory to IFDC. The monthly technical progress reports will be via email and provide a brief report on the status of activities being undertaken to implement this project during the previous 30 days. The requirement of the final monthly report for each quarter will be satisfied by the quarterly progress report as defined below.

The quarterly reports shall indicate progress toward achieving the study objective and implementing the NAS proposal. The reports shall include, but not be limited to, the following information:

- Status of achievement of program goals, objectives, and benchmarks specified in the Academy's proposal.
- Progress or completion of components, elements, or activities against planned targets, if any.
- Program description
- Other accomplishments or program highlights
- Identification and explanation of significant problems which have been encountered
- Description of planned corrective action

The monthly and quarterly reports may be submitted in electronic format and are to be delivered to IFDC within 7 calendar days and 20 calendar days, respectively, of the end of the reporting period. The Academy's final study report may take the place of the final progress report and shall address all of the components indicated above. The final report shall be submitted to IFDC within 45 days of the ending date of this MOU.

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NAS is also required to submit copies of reports/publications, produced within each activity as requested by the USAID Cognizant Technical Officer (e.g., workshop proceedings, PowerPoint presentations, etc.).

2.5.4 Termination

This agreement may be terminated, in whole or in part, by either party at any time upon 30 days written notice of termination. Upon receipt of and in accordance with a termination notice from the IFDC, the NAS shall take immediate action to cease all expenditures financed by this MOU and to cancel all unliquidated obligations if possible. Further, upon receipt of notice of termination, the NAS shall not enter into any further obligations under this MOU. Except as provided below, no further reimbursement shall be made after the effective date of termination. The NAS shall within 30 days of the effective date of termination repay to IFDC all unexpended funds that are not otherwise necessary to reasonably close down the activity or are obligated by a legally binding transaction applicable to this MOU. Should the funds paid by IFDC to the NAS prior to the effective date of termination be insufficient to cover the NAS's obligations in a legally binding transaction, the NAS may submit to IFDC within 90 days after the effective date of termination a written claim for such amount. The IFDC shall determine the amount(s) to be paid by IFDC to the NAS under such claim in accordance with the "Allowable Costs" provision of this MOU.

2.5.5 Dispute Settlement

One or more arbitrators appointed in accordance with the said Rules shall finally settle any dispute or difference arising out of this MOU or in connection with it that cannot be amicably settled between the parties under the Rules of Conciliation and Arbitration of the International Chamber of Commerce. The arbitration shall take place via mail, or in Muscle Shoals, Alabama, or any other place acceptable to IFDC and the NAS. The resulting award shall be final and binding on the parties and shall be in lieu of any other remedy.

2.5.6 Investment Promotions

No funds or other support provided hereunder may be used in a program or activity reasonably likely to involve the relocation or expansion outside of the United States of an enterprise located in the United States if non-US production in such relocation or expansion replaces some or all of the production of, and reduces the number of employees at, said enterprise in the United States.

No funds or other support provided hereunder may be used in a program or activity the purpose of which is the establishment or development in a foreign country of any export processing zone or designated area where the labor, environmental, tax, tariff, and safety laws of the country would not apply, without the prior written approval of IFDC.

No funds or other support provided hereunder may be used in an activity which contributes to the violation of internationally recognized rights of workers in the recipient country including those in any designated zone or area in that country. This provision must be included in all subagreements.

2.5.7 Non-Liability

NAS agrees to hold IFDC free from any third party claims for damages arising out of this MOU.

2.5.8 Notices

Any notice given by either party under this MOU shall be sufficient only if in writing and delivered in person or faxed to the official (technical and business) contact persons identified in 2.5.1

2.5.9 Special Provisions

NAS shall comply with USAID environmental regulations (22 CFR Section 216 "Regulation 16") with respect to the activities to be undertaken under this MOU. If NAS has made a determination that it is excluded from this requirement, NAS

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shall (upon request by USAID) provide to USAID documentation to support its determination. NAS agrees to comply with USAID requirements to properly resolve in outstanding issues under this article .

2.5.10 Procurement Policies and Procedures

Because USAID is the sole contributor, USAID procurement policies and procedures are applicable (22 CFR Section 226 and ADS 308.5.7a).

2.5.11 Ineligible Countries

Activities under this agreement may only be carried out in countries that are eligible to receive assistance under the Foreign Assistance Act. NAS shall provide IFDC in advance a list of those countries where activities are planned under this MOU.

2.5.12 Entire MOU

Unless otherwise specified, this MOU embodies the entire understanding between IFDC and NAS for the NAS study to be conducted and any prior to contemporaneous representations, either oral or written, are hereby superseded. No amendments or changes to this MOU, including, without limitation, changes in the statement of work, total estimated cost, and period of performance, shall be effective unless made in writing and signed by authorized representatives of the parties.

FOR AND ON BEHALF OF IFDC

By: _____

Name: BY JOHN H ALLGOOD

Title: DIRECTOR OF ADMINISTRATION

Date: 12/3/01

FOR AND ON BEHALF OF NAS

By: _____

Name: _____

Title: DAVID P. WESTBROOK
Associate Director
Office of Contracts and Grants

Date: DEC 12 2001

WITNESS:

By: _____

Name: LAWRENCE HAMMOND

Title: Director, R+D Division

Date: 12/3/01

WITNESS:

By: _____

Name: _____

Title: Douglas E. Denning
Contract Manager

Date: DEC 12 2001

THE NATIONAL ACADEMIES
DIVISION ON EARTH AND LIFE STUDIES
BOARD ON EARTH SCIENCES AND RESOURCES
COMMITTEE ON GEOGRAPHY

The Geographic Foundation for Agenda 21

SUMMARY

This proposal is a request to the U.S. Agency for International Development to provide partial support in the amount of $75,000 for a thirteen-month study and report *on The Geographic Foundation for Agenda 21*. Support is being requested from the following private and public organizations: the U.S. Department of State, National Aeronautics and Space Administration, the National Oceanic and Atmospheric Administration, National Imagery and Mapping Agency, the U.S. Geological Survey, and the Environmental Systems Research Institute.

CONTEXT

Policy Context:

The next World Summit in Johannesburg in September 2002 will be a forum for world leaders to address progress made on the "Agenda 21" issues raised at the previous summit in Rio de Janiero in 1992. Leaders will assess, for example, problems tied to environmental degradation, management of natural resources, poverty, and food security. Many needs identified by Agenda 21 remain to be addressed. These needs fall into five categories. They are: (1) substantial gains in food resource productivity while reducing or limiting land degradation and impact of fertilizers and irrigation and pesticides and waste management practices on ecosystems; (2) generation of more energy with less impact on local, regional and global health and environment from emissions and energy generation activities; (3) generation of goods and services, including transportation, with lower materials and energy intensities; (4) more efficient and sustainable use of water resources, including coastal zone management, in ways that preserve important services performed by ecosystems; and (5) better methods of addressing evolving trends including urbanization and human health issues in the contexts of food security, energy, infrastructure development and integrated water-resource management.

Since the World Summit of 1992 there have been significant improvements in the earth observation data and the information management systems that can help address the above issues at global, regional, and local scales. A wealth of United States Government (USG)-generated spatial data and the means to deliver these data now exist. The challenge is how these data can be made more accessible and applicable to development problems, including the integration of data across multiple scales and sectors (for example local to global scales and environmental, social, and economic sectors).

As a component of the United States' contribution to the World Summit, the St
has developed the "World Summit on Sustainable Development Geographic In
(WSSDGIP). This is a multi-agency effort, with a proposed integral contributi
National Research Council. The overall project goal is to develop and present
Summit a package of accessible remote-sensing data and other geographic inf
fundamental relevance to future natural resource management decision-making. The focus of this effort will be a suite of case-study regions in Africa: (a) Limpopo river system in southern Africa; (b) upper Niger basin in northwest Africa; (c) Kenya/Tanzania coast of East Africa; and d) Lake Victoria in Central Africa.

Although the objective of providing geographic information to national and local decision-makers has relevance to all world regions, the World Summit venue and the pressing needs of Africans justify a focus on sharing earth observation data with organizations already coping with specific sets of issues in Africa. The WSSDGIP will highlight specific examples of applications in Africa, in pursuit of the following goals: a) the promotion of economic development in poor regions by improving the quality of information related to the natural-resource base on which their economies depend, b) to facilitate the planning for and response to humanitarian crises and natural hazards by improving both national governments' and the international community's ability to assess factors that place vulnerable populations at heightened risk from natural disasters, c) to promote environmentally sound development and better protection of threatened ecosystems by using earth observation and other data to show the consequences of short-sighted land use policies, and d) to help the international community in its efforts to improve public health by demonstrating the linkages between environmental change and infectious disease vectors. ? { Environment + Health

The World Summit is an opportunity to realize the value of a substantial USG investment already made in collecting earth observation data for tackling real-world demands. In addition, a USG presentation at the World Summit could underscore the Administration's commitment to apply relevant data to address Africa's development problems - not by "dumping" data across the digital divide but by working with institutions in the continent (following USAID's lead) that are committed to making a difference. An effective "package" requires an outreach strategy that includes an examination of (1) lessons learned by EPA, NASA, NIMA, NOAA, USAID, USDA, USGS, and other entities with experience in geospatial-data issues in Africa, and (2) appropriate applications for remote sensing, GIS, and decision-support systems and tools. In bringing together leading earth scientists, the National Research Council, through such an examination, would provide an intellectual basis upon which efforts building up to the World Summit could be sustained beyond the meeting itself.

Technical Context:

The public and private sectors in the United States have led in the collection of earth observation data (from LandSat to Ikonos), the technologies that allow such data to be accurately georeferenced (global positioning system, or GPS) and organized and displayed (GIS), and the telecommunications media that allow such data to be broadly and quickly disseminated internationally (the Internet). Moreover, American scientists working with counterparts from

around the world have undertaken pioneering work in applying these data and technologies to a wide range of pressing natural-resource management problems - from forest fire prevention to urban planning. The United States can bring to the World Summit these decision-making capabilities in a way that will not impose foreign solutions but rather provide the information for local and national resource managers to make decisions for themselves.

Several types of earth observation data that were unavailable in 1992 are now available and of significant relevance to Agenda 21 concerns: the georeferenced imagery record taken by NASA's successive Landsat satellites can document the rapid land-use changes that have occurred since 1970; the digital elevation data taken by the NASA/NIMA Shuttle Radar Topography Mission (SRTM) can provide a new comprehensive topographic map of the world that far surpasses all previous ad hoc efforts; AVHRR and other low-resolution imagery from NOAA and NASA can now provide timely climatic data for crop projections and disaster preparedness; and the Oak Ridge National Laboratory's LandScan population distribution model can provide a means to quickly estimate the vulnerability of populations to natural disasters, especially in regions of Africa where current census data are often lacking.

WHO? An abundance of earth observation data is of little value if it cannot be provided to those who need it most. Hence, issues of access to and effective use of the data and associated technology are central to the proposed NRC study. A relevant data-management tool that is applied to remote-sensing imagery is a GIS. This tool can integrate georeferenced imagery as data layers that are then linked directly to other data layers over a given area. Commercial GIS tools, especially when connected to GPS-enhanced field data, share a location-based methodology that is profoundly impacting resource management. Complementing advances in GIS, the Internet and new kinds of data-management and transmission capabilities - such as Internet Map Server tools that allow users to query remotely sensed and other geographic data - offer a world of data if they can be accessed. However, many developing countries still lack adequate Internet access and even those that do still need assistance in tapping into the full utility of the Internet. Organizations such as USGS's EROS data center have done pioneering work in collecting, analyzing and disseminating NASA, NOAA and other earth observation data in Africa and elsewhere. Ongoing challenges include a) how to make best use of existing technology and technology within practical economic reach, and b) how to integrate into decision-support tools data of different scale, accuracy, and origin.

Earlier Work:

Toward a Coordinated Spatial Data Infrastructure for the Nation (NRC, 1993)
Sustainable Agriculture and the Environment in the Humid Tropics (NRC, 1993)
Promoting the National Spatial Data Infrastructure Through Partnerships (NRC, 1994)
Finding the Forest in the Trees: The Challenge of Combining Diverse Environmental Data (NRC, 1995)
A data foundation for the National Spatial Data Infrastructure (NRC, 1995)
Mineral Resources and Sustainability (NRC, 1996)
The Future of Spatial Data and Society: Summary of a Workshop (NRC, 1997)
Rediscovering Geography: New Relevance for Science and Society (NRC, 1997)

Bits of Power: Issues in Global Access to Scientific Data (NRC, 1977)
People and Pixels: Linking Remote Sensing and Social Science (NRC, 1998)
Our Common Journey: a transition towards sustainability (NRC, 1999)
A Question of Balance (NRC, 1999)
Distributed Geolibraries: Spatial Information Resources (NRC, 1999)
The Science of Regional and Global Change: Putting Knowledge to Work (NRC, 2000)

PLAN OF ACTION

Statement of Task:

As a component of the State Department's contribution to the World Summit in Johannesburg (September 2002), this study will examine the geographic foundation for natural resource management and development issues in Africa. Specific examples will be drawn from case-study regions where USAID and other agencies have broad experience. Centered on a place-based, integrative framework, the study will draw on experiences of U.S. government agencies, international groups, decision-makers, and experts to examine 1) existing remote-sensing and GIS efforts in case-study regions, and lessons learned from those efforts, 2) existing levels of local expertise and technology, and ongoing efforts in geospatial capacity building, 3) a range of questions relating to the practical application of new and existing spatial data (e.g. required resolution, challenges of integrating layers of environmental and social data, and baseline data against which future change can be measured); 4) the role of decision support systems in the application of these data; and 5) options for making efforts sustainable beyond 2002.

Preliminary Work Plan:

An ad hoc committee of 10 national and international members with expertise in geographic information science, geography, remote sensing, natural resource management, development planning, demographic issues, policy, decision support systems, and technology transfer will be appointed. The committee will operate under the auspices of the Committee on Geography and the Mapping Science Committee

The study will require five meetings. Following an initial planning meeting, the committee will hear testimony on data availability and existing efforts (U.S. and foreign) in the case-study regions. The third meeting, involving a subset of the committee, will coordinate with the "AFRICA GIS" meeting in November 2001 in Nairobi, Kenya, to learn first-hand from those involved in GIS issues in Africa, including details of existing geospatial infrastructure. The fourth meeting will focus on geospatial capacity building efforts, and future prospects for data, partnerships, and technology in the case-study regions. This meeting will identify a) impediments to full realization of the benefits of geographic information science for development, and b) measures to remove these impediments. A final writing meeting will complete the meeting schedule. The consensus report is due by August 1, 2002 for dissemination at the Johannesburg meeting in September 2002.

REPORTING

Reports resulting from any of the activities of the Board on Earth Sciences and Resources will be made available to the public without restrictions and will be prepared in sufficient quantity to ensure adequate public distribution in accordance with NRC policy. In addition, they will also be posted on the relevant pages of the NAS World Wide Web site.

FEDERAL ADVISORY COMMITTEE ACT (FACA)

The Academy has developed interim policies and procedures to implement Section 15 of the Federal Advisory Committee Act, 5 U.S.C. App. § 15. Section 15 includes certain requirements regarding public access and conflicts of interest that are applicable to agreements under which the Academy, using a committee, provides advice or recommendations to a Federal agency. In accordance with Section 15 of FACA, the Academy shall submit to the government sponsor(s) following delivery of each applicable report a certification that the policies and procedures of the Academy that implement Section 15 of FACA have been substantially complied with in the performance of the contract/grant/cooperative agreement with respect to the applicable report.

PUBLIC INFORMATION ABOUT THE PROJECT

In order to afford the public greater knowledge of Academy activities and an opportunity to provide comments on those activities, the Academy may post on its website (http://www.national-academies.org) the following information as appropriate under its procedures: (1) notices of meetings open to the public; (2) brief descriptions of projects; (3) committee appointments, if any (including biographies of committee members); (4) report information; and (5) any other pertinent information.

ESTIMATE OF COSTS

The total estimated cost of this activity is $399,950 for the thirteen-month period from September 1, 2001 to September 30, 2002, of which $75,000 is requested from the U.S. Agency for International Development.

THE NATIONAL ACADEMIES

NATIONAL ACADEMY OF SCIENCES
INSTITUTE OF MEDICINE

NATIONAL ACADEMY OF ENGINEERING
NATIONAL RESEARCH COUNCIL

DIVISION OF EARTH AND LIFE STUDIES
BOARD ON EARTH SCIENCES AND RESOURCES
COMMITTEE ON GEOGRAPHY

Proposal No. 01-DELS-208-04

The Geographic Foundation for Agenda 21

U.S. Agency for International Development Summary Estimate of Costs

9/1/2001 to 9/30/2002

			AMOUNT
Direct Labor			$18,388
Overhead			$10,389
Overhead Cost of Money			$209
Travel			$25,217
Reports			$4,919
Technology/Communication			$1,977
Meeting Expense			$720
Other Direct Costs			$895
	Subtotal:	$62,714	
General and Administrative Costs			$12,229
G&A Cost of Money			$57
	Total:	$75,000	

Amount Requested From the U.S. Agency for International Development $75,000

Footnote: These major cost categories reflect the billing structure used by the National Academy of Sciences. Cost and rate data are attached as background information and for use in the negotiation process. Please be advised, however, that all costs are systematically collected in our accounting system and are available for audit through arrangements with the Defense Contract Audit Agency and our cognizant Administrative Contracting Officer at the Office of Naval Research.

THE NATIONAL ACADEMIES
DIVISION OF EARTH AND LIFE STUDIES
BOARD ON EARTH SCIENCES AND RESOURCES
COMMITTEE ON GEOGRAPHY
MAPPING SCIENCE COMMITTEE

The Geographic Foundation for Agenda 21

Award Number UNNUMBERED

Final Technical Report
December 10, 2001 to September 30, 2002

Sponsor Name: International Fertilizer Development Center

Responsible Staff Officer: Paul Cutler

Project Status Information

Primary objectives and scope

As a component of the U.S. State Department's contribution to the World Summit in Johannesburg (September 2002), this study will examine the geographic foundation for natural resource management and development issues in Africa. Specific examples will be drawn from case-study regions where USAID and other agencies have broad experience. Centered on a place-based, integrative framework, the study will draw on experiences of U.S. government agencies, international groups, decision-makers, and experts to examine 1) existing remote-sensing and GIS efforts in case-study regions, and lessons learned from those efforts, 2) existing levels of local expertise and technology, and ongoing efforts in geospatial capacity building, 3) a range of questions relating to the practical application of new and existing spatial data (e.g. required resolution, challenges of integrating layers of environmental and social data, and baseline data against which future change can be measured); 4) the role of decision support systems in the application of these data; and 5) options for making efforts sustainable beyond 2002.

Description of activities for the report period.

During this period, an expert committee (see attached roster) met four times in the United States and a subcommittee including NRC staff attended conferences in Nairobi, Kenya and Bamako, Mali. Two workshops were held in Washington, D.C. (see attached agendas).

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Identification of work completed and work initiated.

The committee authored a consensus report, entitled *Down to Earth: Geographic Information for Sustainable Development in Africa*. This report was published by National Academy Press in 2002 and is available online at http://www.nap.edu. Hard copy, glossy summaries of the report in French and English, and an eight-page English summary pdf version were produced.

No problems were encountered in the process of this study. No methodological or personnel changes were made.

Summation of work performed for all activities

Committee Meetings

December 13-14, 2001 (Washington, D.C.)
January 10-11, 2002 (Washington, D.C.)
March 11-12, 2002 (Washington, D.C.)
April 18-19, 2002 (Woods Hole, Mass.)

Presentations
Chair and one other committee member to WSSD, Johannesburg, South Africa, August 2002.
Briefing to sponsors (September 2002, National Academies)
GSDI meeting (U.S. Department of State, October 2002)
GISD follow-on meeting (January 2003)
Pecora conference in Denver, Colo. (November 2002)
ICA meeting in Durban (Summer 2003)

Report outreach summary

Materials:
1) 8-pager (paper and pdf)
2) Executive Summary (ES) with full cover and CD of pre-publication
3) French version of ES
4) Final report

Websites:
8-pager posted on U.S. Department of State, Mapping Science Committee site, World Summit (WSSD) site
Report available free of charge online at National Academy Press' website (www.nap.edu)

E-mail distribution:
8-pager sent to all committee members, plus sponsors to freely distribute

Hard Copies:
120 English and 80 French ES with CD sent to WSSD
2500 8-pagers to WSSD
100 8-pagers to GSDI
ES and CD to African embassies in Washington, D.C.
ES and CD to U.S. Embassies and USAID missions in Africa
50 8-pagers at briefing to sponsors, August 7
800 copies of the final reports were distributed to sponsors agencies, project participants, and other interested members of the scientific community.

Attachment 1

DIVISION ON EARTH AND LIFE STUDIES
BOARD ON EARTH SCIENCES AND RESOURCES

The Geographic Foundation for Agenda 21
Membership Roster

John R. Jensen, *Chair*
Carolina Distinguished Research Professor
Department of Geography
University of South Carolina, Columbia

Kwesi Botchwey
Director
Africa Research Programs
Center for International Development
John F. Kennedy School of Government
Harvard University
Cambridge, Massachusetts

Ellen Brennan-Galvin
Fellow, The Woodrow Wilson International Center for Scholars
Washington, D.C.

Christian J. Johannsen
Director
Laboratory for Applications of Remote Sensing (LARS)
Purdue University
West Lafayette, Indiana

Calestous Juma
Research Fellow
Belfer Center for Science and International Affairs
Kennedy School of Government
Harvard University
Cambridge, Massachusetts

Akinlawon L. Mabogunje
Executive Chairman
Development Policy Center
Secretariat
Ibadan, Nigeria

Roberta Balstad Miller
Director
Center for International Earth Sciences Information Network (CIESIN)
Columbia University
Palisades, New York

Kevin P. Price
Associate Director
Kansas Applied Remote Sensing (KARS) Program
University of Kansas, Lawrence

Priscilla A. C. Reining
Washington, D.C.

David Skole
Professor and Director
Department of Geography
Michigan State University
East Lansing

Andrew Stancioff
Senior Associate
Stone Environmental Inc.
Washington, D.C.

D. R. Fraser Taylor
Professor
Department of Geography & Environmental Studies
Carleton University
Ottawa, Ontario
Canada

NRC Staff

Paul Cutler, Program Officer
Pcutler@nas.edu
Lisa M. Vandemark, Program Officer
lvandema@nas.edu
Kristen Krapf, Research Associate
Kkrapf@nas.edu
Teresia Wilmore, Project Assistant
Twilmore@nas.edu

Attachment 2

NATIONAL RESEARCH COUNCIL
BOARD ON EARTH SCIENCES AND RESOURCES

Committee on The Geographic Foundation for Agenda 21

First Meeting, Agenda

Cecil and Ida Green Building,
2001 Wisconsin Avenue
Washington, DC

Room 110

December 13-14, 2001

Thursday, December 13, 2001

Day 1

CLOSED SESSION

8:00 a.m. Continental breakfast in meeting room

8:30 a.m. Welcome
John Jensen/ Lisa Vandemark/ Paul Cutler

8:35 a.m. Composition and Balance Discussion.
Gregory Symmes, Assistant Executive Director, Division of Earth and Life Studies, NRC.

10:00 a.m. Summary of Activities so far.
John Jensen/ Lisa Vandemark/ Paul Cutler

10:15 a.m. Break

OPEN SESSION

10:30 a.m. Overview of the State Department-led *Geographic Information for Sustainable Development* project.
William Wood, Deputy Assistant Secretary for Analysis and Information Management, Bureau of Intelligence and Research and Geographer, U.S. Department of State.

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11:00 a.m. Perspectives on Development in Africa.

Overview of Activities in Four Case Study Regions in Africa.
Robert Ford, Natural Resources Advisor, U.S. Agency for International Development.

Geographic Information Activities Addressing Environment and Natural Resource Management Issues in Africa.
Fernando Echavarria, Space & Advanced Technology Staff, U.S. Department of State.
Paul Bartel, Environmental Analyst and Policy Advisor, Africa Bureau, U.S. Agency for International Development.

Technical Perspectives on Environment and Development Initiatives in Africa.
Robert Winterbottom, Senior Manager, Environment and Natural Resources Division, International Resources Group (IRG).

12:30 p.m. Lunch

1:30 p.m. EIS-Africa – An introduction and overview.
Daniel Tunstall, Director, Information Program, World Resources Institute, Washington, D.C.

CLOSED SESSION

2:15 – 5:30 p.m.

5:30 p.m. Adjourn

Day 2

OPEN SESSION

8:00 a.m.	Continental breakfast in meeting room.
8:30	USGS: Ongoing and planned activities in Africa. (Africa Program, HYDRO1K, Last 30 yrs of Landsat data) *James Verdin*, International Program Manager, Eros Data Center, U.S. Geological Survey.
9:30	NASA: Landsat 7, Landsat Follow-on, World Landcover Map, Planned future missions of relevance to Africa. *Charles Hutchinson*, Acting Director, Applications Division in the Office of Earth Science, NASA.
10:30	Break
10:45	NOAA's Global Operational Environmental Monitoring Mission: Focus on atmospheric, terrestrial, coastal applications of geospatial data. *Charles Wooldridge*, Chief of Staff, National Environmental Satellite Data and Information Service (NESDIS). *Jane D'Aguanno*, Technical Assistant to the Deputy Assistant Administrator of NESDIS.
11:45 a.m.	Lunch
12:45 p.m.	The Status of the Telecommunications Industry in Africa. *Lane Smith*, Consultant, U.S. Agency for International Development Africa Bureau.
1:45 p.m.	CORONA Data: Availability and details of coverage in Africa *John Cloud*, Peace Studies Program, Cornell University.
2:15 p.m.	Break

CLOSED SESSION

2:30 p.m.	Committee Deliberations
5:00 p.m.	Adjourn

NATIONAL RESEARCH COUNCIL
BOARD ON EARTH SCIENCES AND RESOURCES

Committee on The Geographic Foundation for Agenda 21

Cecil and Ida Green Building,
2001 Wisconsin Avenue, Room 118
Washington, D.C.

January 10-11, 2001

Preliminary Agenda

Thursday, January 10, 2002

OPEN SESSION

8:30-12:30 a.m.	**Activities in Four Case Study Areas**
8:30	***Upper Niger:*** *André Bassolé, EIS-Africa*
9:30	***African Great Lakes:*** *Kristen Rose Mwebaza, Uganda Access Initiative Case Study*
10:30	Break
10:45	***Kenya/Tanzania Coast:*** *Lynne Z. Hale, University of Rhode Island, and Barbara Best, USAID*
11:45	***Limpopo/Zambezi:*** *Paul Desanker, University of Virginia and IGBP/START Miombo Network*
12:30 p.m.	Lunch
1:30-2:30	**Decision Support Systems**
1:30	*Spatial Decision Support Systems for Sustainable Development: Ron Eastman, Clark University*
2:30 -5:45	**Technology Transfer Issues**
2:30	*Technology Transfer: Barry Haack, George Mason University*
3:30	Break

NATIONAL RESEARCH COUNCIL
BOARD ON EARTH SCIENCES AND RESOURCES

Committee on The Geographic Foundation for Agenda 21

Cecil and Ida Green Building,
2001 Wisconsin Avenue, Room 118
Washington, D.C.

Preliminary Agenda

Friday, January 11, 2002

OPEN SESSION

8:30-10:30 a.m.	**Capacity Building**
8:30	*ITC initiatives in Africa: Sjaak J.J. Beerens, International Institute for Geo-information Science and Earth Observation*
9:30	*Workforce Issues in West Africa: André Bassolé, EIS-Africa*
10:30	Break
10:45-12:45 p.m.	**United Nations Initiatives in Africa**
10: 45	*FAO Africover Initiative: John S. Latham, FAO*
11:45	*UNECA Geographic Information Initiative: Dozie Ezigbalike, UNECA*
12:45	Lunch

CLOSED SESSION

1:30-5:00	Closed Committee Deliberations
5:00 pm	Adjourn

GISD Project
Annex 7

Subcontract With
Open GIS Consortium (OGC)
IFDC Contract # 01604/02

1. Project Summary Page
2. Project Memorandum of Understanding
3. Project Final Report

	Project Summary Page
MOU Lead Implementation Organization	**Open GIS Consortium**
Contact Person	Mr. Mark Reichardt Director, Marketing and Public Sector Programs Open GIS Consortium 13312 Wye Oak Drive Gaithersburg, MD 20878, USA Phone: 301/840-1361 Fax: 301/330-2839 mreichardt@opengis.org
Project/Program and Statement of Work	Target Region 5: Africa-Wide Capacity Building & Synthesis Projects: **Open GIS Consortium (OGC) Sustainable Development Pilot Project** OGC will develop and implement a limited but operational interoperable technology framework for the discovery, access, rapid integration and application of critical spatial information relevant to sustainable development issues on the ground in Africa; and will plan and conduct a pilot project to implement a framework of interoperable standards-based commercial offerings in one to two of the four sites identified by initiative sponsors for the upcoming World Summit on Sustainable Development (scheduled for November 2002 in South Africa). A description of the activities to be undertaken by OGC, technical procedures to be followed, deliverables required, and estimated schedule are presented in Attachment 1. Attachment 1 is incorporated as an integral part of this Memorandum of Understanding (MOU).
Collaborating Institutions	
IFDC Contract Number	01604.02
Budget Amount	Signed contract with Open GIS Consortium for $100,000 on January 7, 2002
Amendment(s)	
Extension Ending Date	

IFDC■01604 02

IFDC INTERNATIONAL FERTILIZER DEVELOPMENT CENTER • MUSCLE SHOALS ALABAMA 35662 USA
P.O. BOX 2040 • 256-381-6600
EMAIL-general@IFDC.org
TELEFAX NO. 256-381-7408

Memorandum of Understanding

Between

International Fertilizer Development Center
PO Box 2040
Muscle Shoals, AL 35662, USA

And

Open GIS Consortium
35 Main Street, Suite 5
Wayland, MA 01778, USA

October 1, 2001

IFDC INTERNATIONAL FERTILIZER DEVELOPMENT CENTER • MUSCLE SHOALS ALABAMA 35662 USA
P.O BOX 2040 • 256-381-6600
EMAIL-general@IFDC.org
TELEFAX NO. 256-381-7408

Memorandum of Understanding

Between

International Fertilizer Development Center
PO Box 2040
Muscle Shoals, AL 35662, USA

And

Open GIS Consortium
35 Main Street, Suite 5
Wayland, MA 01778, USA

The International Fertilizer Development Center (hereinafter referred to as IFDC) is a public international organization (PIO) dedicated to increasing sustainable agricultural production through the improved use of yield enhancing technologies. The Open GIS Consortium has submitted a proposal to USAID to support development and implementation of a limited but operational interoperable technology framework for the discovery, access, rapid integration and application of critical spatial information relevant to sustainable development issues on the ground in Africa. In order to carryout the work described herein, IFDC and OGC hereby agree to the following terms and conditions:

1 INTRODUCTION AND STATEMENT OF WORK

The United States Agency for International Development (USAID) has entered into an Agreement with IFDC for IFDC to undertake a project entitled "Quick Start for Agriculture in Africa" to support the Geographic Information for Sustainable Development (GISD) project leading up to the World Summit on Sustainable Development (WSSD).

IFDC will provide USAID EGAD AFS with logistical and management support to the various partners involved in the implementation of the GISD project, including transferring and providing overall fiscal oversight to specific "pass-through" funds to selected partners who are

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being asked to implement specific GISD activities. This will include work already identified in specific proposals from the NRC, OGC, and several other groups located in the four Target Regions: Upper Niger Basin, African Great Lakes Region, the Kenya-Tanzania Coastal Zone, and the Limpopo/Zambeze River Basin Region of southern Africa.

IFDC will work in close collaboration with the technical officers within USAID providing oversight: Note: The Overall Coordinator is Robert E. Ford, AEMD – Agricultural Enterprise and Market Development Division within USAID's office of Agriculture and Food Security. Robert E. Ford is the Chair of the GISD-IWG for Regional Applications sub-group.

Close coordination must also occur with co-Chairs of the GISD-IWG for each sub-region. They are: Barbara Best (G/ENV) for the Kenya-Tanzania CZM Activity; Paul Bartel and Jon Anderson (AFR-SD) for the Four Corners/Limpopo/Zambezi Basin region; Robert Ford for the Great Lakes/Great Horn of Africa Region; and Mike McGahuey (USAID/AFR-SD).

OGC will develop and implement a limited but operational interoperable technology framework for the discovery, access, rapid integration and application of critical spatial information relevant to sustainable development issues on the ground in Africa. This will be accomplished by conducting an OGC pilot project to implement a framework of interoperable standards-based commercial offerings in one to two of the four sites identified by initiative sponsors for the upcoming World Summit on Sustainable Development (scheduled for November 2002 in South Africa). This framework will be deleveloped based on funding provided by USAID (under this MOU) and by the US Department of State as detailed in Attachment 1. Furthermore, other sponsors will be sought to provide additional funding for completion of all items identified in Attachment 1. A description of the activities to be undertaken by OGC, technical procedures to be followed, deliverables required, and estimated schedule are presented in Attachment 1, which is incorporated as an integral part of this Memorandum of Understanding (MOU).

2 SPECIFIC CONDITIONS

2.1 Effective Dates of MOU

The effective dates of this MOU are October 1, 2001-September 30, 2002.

2.2 Finances

The work to be performed under this MOU is being financed by USAID with all funds channeled to IFDC. IFDC shall provide funding to OGC in accordance with the terms and conditions described in this MOU. OGC shall develop subagreements as necessary to support funding arrangements and the work to be performed by its collaborating institutions. The estimated funds available to OGC total US $100,000 (one hundred thousand) as follows:

Item	Labor (US $)	OH (US $)	G&A (US $)
GISD Pilot Execution – supplemental funding to conduct Pilot as described under 3.1.4 of the OGC Sustainable Development Pilot Project Proposal, and Cost Annex A			
OGC Project Lead	975	1,004	489
OGC Study Team Members (directors)	3,899	4,016	1,955
OGC Study Team Members (vice presidents)	2,129	2,193	1,068
Interoperability Team Members (outsourced)	9,747	N A	2,437
Participant Budget (outsourced)	56,231	N A	13,859
Column Subtotals	**72,981**	**7,213**	**19,808**
USAID Total Applied to Pilot Execution			**100,000**

2.2.1 Use of Funds

IFDC has fiduciary responsibility of funds received from USAID. Under the terms of this MOU, all funds provided to OGC shall be utilized solely for the purposes indicated in the budget under 2.2. Said funds shall cover all expenditures necessary for the services to be performed by and or arranged by

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OGC. IFDC shall not be responsible for any additional costs (i.e., above US $100,000) incurred in the performance of the work described under this MOU.

2.2.2 Allowable Costs

(a) OGC shall be reimbursed for costs incurred in carrying out the purposes of this MOU, which are reasonable, allocable, and allowable.

(b) Reasonable shall mean those costs that do not exceed those which would be incurred by an ordinarily prudent person in the conduct of normal business.

(c) Allocable shall mean those costs which are necessary to the MOU.

(d) Allowable shall mean those costs which are reasonable and allocable, and which conform to any limitations set forth in this MOU.

(e) Prior to incurring a questionable or unique cost, OGC is encouraged to obtain IFDC's written determination as to whether the cost will be allowable.

(f) The overhead and G&A rates indicated in the budget line items under 2.2 Finances are allowable unless determined otherwise by USAID. In the event USAID disallows the proposed rates, overhead and G&A rates will be calculated in accordance with the rates as determined in the applicable DCAA audit.

2.2.3 Payments

IFDC shall make payments to OGC subject to the receipt of funds from USAID and based upon receipt of an official invoice from OGC. The invoice may be faxed to the official IFDC Business Contact indicated in 2.6.1. The payments shall be made on a monthly basis based upon OGC'S submission of financial reports, which substantiate costs incurred in the performance of this MOU.

2.2.4 Financial Reports

OGC shall provide to IFDC, within 20 days of the end of each month under this program, a financial report indicating funds received from IFDC, funds expended

under this MOU, and the balance of funds on hand. The financial reports shall include accounting for all allowable costs incurred by OGC under the program in accordance with the line item budget amounts indicated in 2.2. Copies of documentation to support all costs incurred in performance of work described in this MOU shall be included in the financial reports.

2.2.5 Audit

OGC shall maintain books, records, documents, and other evidence in accordance with OGC's usual accounting procedures to sufficiently substantiate charges to this MOU. IFDC and USAID reserve the right to examine and OGC agrees to make available all financial records and documents of OGC as related to this MOU. Any costs that are determined by either IFDC or USAID to be inconsistent with the terms and conditions of this MOU shall immediately be refunded to IFDC. OGC is subject to the audit guidelines and provisions of 22 CFR Section 226.26. In accordance with the provisions of OMB Circular A-133, OGC is obligated to comply with the requirements of OMB Circular A-133. OGC is required to have an audit in full compliance with the guidelines of OMB A-133 and agrees that a copy of the audit report will be submitted to IFDC's supervisor, Accounting Services, by OGC within thirty (30) days of completion of the audit. By the signing of this MOU, OGC states that they were informed of, understand, and agree to comply with the applicable compliance requirements.

2.2.6 Refunds

(a) If OGC earns interest on advances under this MOU prior to expending the funds for program purposes, OGC shall remit the interest to IFDC or deduct the same from subsequent invoices of planned monthly expenditures in accordance with 2.2.3.

(b) Funds not disbursed to OGC at the time the MOU expires or is terminated shall revert to IFDC, except for such funds encumbered by OGC by a legally binding transaction applicable to this MOU. Any funds advanced to but not expended by OGC at the time of expiration or termination of the

BEST AVAILABLE

MOU shall be refunded to IFDC except for such funds encumbered by OGC by a legally binding transaction applicable to this MOU.

(c) If, at any time during the life of the MOU, or as a result of final audit, it is determined that funds provided under this MOU have been expended for purposes not in accordance with the terms of this MOU, OGC shall refund such amount to IFDC.

2.3 Language

The MOU has been executed in English, which shall be the binding and controlling language for interpretation of the terms and conditions of this MOU.

2.4 Subagreements

It is understood that OGC may carryout the work described under this MOU in collaboration with others. It is further understood that funds provided to OGC may be used to support work carried out by collaborating institutions. OGC shall ensure that the specific conditions of this MOU (i.e., Section 2.0, Specific Conditions) shall apply to all such subagreements.

2.5 Revision of MOU Budget

(a) The approved MOU budget is the financial expression of OGC's program.

(b) OGC shall immediately request approval from IFDC when there is reason to believe that within the next 30 calendar days a revision of the approved MOU budget will be necessary for any of the following reasons:

- To change the scope or the objectives of the program and/or revise the funding allocated among objectives by more than ten percent of the total budget amount unless the schedule states otherwise.
- Additional funding is needed.
- OGC expects the amount of authorized funds to exceed its needs by more than $5,000 or five percent of the MOU budget, whichever is greater.

(c) Except as required by other provisions of this MOU specifically stated to be an exception from this provision, IFDC shall not be obligated to reimburse

OGC for costs incurred in excess of the total amount obligated under the MOU. OGC shall not be obligated to continue performance under the MOU (including actions under the "Termination Procedures" provision) or otherwise to incur costs in excess of the amount obligated under the MOU, unless and until IFDC has notified OGC in writing that such obligated amount has been increased and has specified the new MOU total amount.

2.6 Other Terms and Conditions

The following terms and conditions, which are applicable to the grant agreement by and between USAID and IFDC, shall be integral part of this Agreement.

2.6.1 Official Contacts

The contacts under this MOU for all official contacts are as follows:

IFDC Technical
Dr. Lawrence L. Hammond
Director, Research and Development Division
IFDC
PO Box 2040
Muscle Shoals, AL 35662, USA
Telephone: 256/381-6600, extension 270
FAX: 256/381-7408
lhammond@ifdc.org
www.ifdc.org

IFDC Business
Mr. John H. Allgood
Director, Finance, Administration, and Support Services
IFDC
PO Box 2040
Muscle Shoals, AL 35662, USA
Telephone: 256/381-6600, extension 211
FAX: 256/381-7408
jallgood@ifdc.org
www.ifdc.org

OGC Technical
Mr. Mark Reichardt
Director, Marketing and Public Sector Programs
Open GIS Consortium
13312 Wye Oak Drive
Gaithersburg, Maryland, USA 20878
Phone: 301/840-1361
Fax: 301/330-2839
mreichardt@opengis.org

OGC Business
Mr. Jeff Burnett
Vice President, Operations & Finance
Open GIS Consortium
35 Main Street, Suite 5
Wayland, MA 01778-5306
Phone: (508) 655-5858
Fax: (508) 655-2237
Jburnette@opengis.org

2.6.1 Intellectual Property Rights

OGC programs are designed to result in open interfaces and documented specifications that are made openly available to the public. Therefore:

(a) Each sponsor of this Pilot (e.g. USAID, US Department of State) shall retain ownership of all intellectual property developed and/or purchased by Sponsor or on Sponsor's behalf prior to this Agreement or that is not developed during the course of Sponsor's participation in the GISD Pilot.

(b) OGC is the sole and exclusive owner of any and all intellectual property developed during the course of the GISD Pilot and any modifications to such intellectual property, except to the extent there is a separate intellectual property rights policy or other agreement in place governing the ownership rights of such intellectual property. USAID reserves a royalty-free nonexclusive and irrevocable right to use such intellectual property for U.S. Government purposes.

2.6.2 Publications and Media Release

If it is OGC's intention to identify USAID's contribution to any publication, video or other information/media product resulting from this MOU, OGC shall state that the views expressed by the author(s) do not necessarily reflect those of USAID. Acknowledgements should identify the sponsoring USAID Office and Bureau or Mission as well as USAID substantially as follows:

"This [publication, video or other information/media project (specific)] was made possible through support provided by the Center for Economic Growth and Agricultural Development, Office of Agriculture and Food Security, under the terms of the MOU. The opinions expressed herein are those of the author(s) and do not necessarily reflect the views of USAID."

OGC shall provide the relevant strategic objective or results package team with one copy of all published works developed under this MOU and with lists of other written work produced under the MOU.

Except as otherwise provided in the terms and conditions of the MOU, the author or OGC is free to copyright any books, publications, or other copyrightable materials developed in the course of or under this MOU, but USAID reserves a royalty-free nonexclusive and irrevocable right to reproduce, publish, or otherwise use, and to authorize others to use the work for U.S. Government purposes.

2.6.3 Reports and Data

OGC shall send to the IFDC Technical Contact at the address included in this MOU, monthly and quarterly progress reports in a form and substance satisfactory to IFDC. The monthly reports will provide a brief report on the status of activities being undertaken to implement this project during the previous 30 days.

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The quarterly reports shall indicate progress toward achieving Program objectives and implementing approved work plans. The reports shall include, but not be limited to, the following information:

- Status of achievement of program goals, objectives, and benchmarks specified in the annual work plan
- Progress or completion of components, elements, or activities against planned targets
- Program description
- Other accomplishments or program highlights
- Identification and explanation of significant problems which have been encountered
- Description of planned corrective action

The monthly and quarterly reports may be submitted in electronic format and are to be delivered to IFDC within 7 calendar days and 20 calendar days, respectively, of the end of the reporting period. A final report addressing the same components included in the quarterly report is to be submitted to IFDC by OGC within 45 calendar days of the ending date of this MOU. The reports submitted to OGC to IFDC and supporting materials compiled in performing the services shall be the property of USAID.

OGC is also required to submit copies of reports/publications, produced within each activity as requested by the USAID Cognizant Technical Officer (e.g., workshop proceedings, PowerPoint presentations, etc.).

2.6.4 Confidentiality

Neither OGC nor any of its employees shall communicate to any person, any unpublished information of a confidential nature known to OGC or the experts by reason of performing this assignment.

2.6.5 Termination

This agreement may be terminated, in whole or in part, by either party at any time upon 30 days written notice of termination. Upon receipt of and in accordance with a termination notice from the IFDC, the OGC shall take immediate action to cease all expenditures financed by this MOU and to cancel all unliquidated obligations if possible. Further, upon receipt of notice of termination, the OGC shall not enter into any further obligations under this MOU. Except as provided below, no further reimbursement shall be made after the effective date of termination. The OGC shall within 30 days of the effective date of termination repay to IFDC all unexpended funds that are not otherwise obligated by a legally binding transaction applicable to this MOU. Should the funds paid by IFDC to the OGC prior to the effective date of termination be insufficient to cover the OGC's obligations in a legally binding transaction, the OGC may submit to IFDC within 90 days after the effective date of termination a written claim for such amount. The IFDC shall determine the amount(s) to be paid by IFDC to the OGC under such claim in accordance with the "Allowable Costs" provision of this MOU.

2.6.6 Dispute Settlement

Because of the nature of this agreement and legal status of the respective organizations engaged under this MOU, reconciliation of disputes which cannot be handled amicably will be settled through discussions negotiations by and between the signatories to the MOU.

2.6.7 Investment Promotions

No funds or other support provided hereunder may be used in a program or activity reasonably likely to involve the relocation or expansion outside of the United States of an enterprise located in the United States if non-US production in such relocation or expansion replaces some or all of the production of, and reduces the number of employees at, said enterprise in the United States.

No funds or other support provided hereunder may be used in a program or activity the purpose of which is the establishment or development in a foreign

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country of any export processing zone or designated area where the labor, environmental, tax, tariff, and safety laws of the country would not apply, without the prior written approval of IFDC.

No funds or other support provided hereunder may be used in an activity which contributes to the violation of internationally recognized rights of workers in the recipient country including those in any designated zone or area in that country. This provision must be included in all subagreements.

2.6.8 Non-Liability

IFDC does not assume liability for any third party claims for damages arising out of this MOU.

2.6.9 Notices

Any notice given by either party under this MOU shall be sufficient only if in writing and delivered in person or faxed to the official contact persons identified in 2.5.1

2.6.10 Special Provisions

OGC shall comply with USAID environmental regulations (22 CFR Section 216 "Regulation 16") with respect to the activities to be undertaken under this MOU.

2.6.11 Procurement Policies and Procedures

Because USAID is the sole contributor, USAID procurement policies and procedures are applicable (22 CFR Section 226 and ADS 308.5.7a).

2.6.12 Ineligible Countries

Activities under this agreement may only be carried out in countries that are eligible to receive assistance under the Foreign Assistance Act. OGC shall provide IFDC in advance a list of those countries where activities are planned under this MOU.

2.6.13 Entire MOU

Unless otherwise specified, this MOU embodies the entire understanding between IFDC and OGC for the services to be provided and any prior to contemporaneous representations, either oral or written, are hereby superseded. No amendments or changes to this MOU, including, without limitation, changes in the statement of work, total estimated cost, and period of performance, shall be effective unless made in writing and signed by authorized representatives of the parties.

FOR AND ON BEHALF OF IFDC

By: _____

Name: JOHN A. ALLGOOD

Title: DIRECTOR, FAD, IFDC

Date: 1/7/02

FOR AND ON BEHALF OF OGC

By: _____

Name: DAVID SCHELL

Title: PRESIDENT

Date: 1/9/02

WITNESS:

By: _____

Name: Amber N. Hammock

Title: Sr. Secretary

Date: January 7, 2002

WITNESS:

By: _____

Name: JEFFREY S. BURNETT

Title: VP Corporate Finance

Date: January 9, 2002

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DRAFT PROPOSAL DRAFT PROPOSAL

E. Target Region 5: Africa-Wide Capacity-Building & Synthesis Projects:

OpenGIS Consortium+DEVECOL Activity--$100,000

NRC (National Research Council) Synthesis Study - $75,000 – Activity as outlined in attached proposal:

See next few pages....

2.6.13 Entire MOU

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Title: PRESIDENT
Date: 1/9/02

WITNESS:

By: _____
Name: Amber N. Hammock
Title: Sr. Secretary
Date: January 7, 2002

WITNESS:

By: _____
Name: JEFFREY S. BUZNER
Title: VP Operations & Finance
Date: January 9, 2002

E. **Target Region 5: Africa-Wide Capacity-Building & Synthesis Projects:**

OpenGIS Consortium+DEVECOL Activity--$100,000

NRC (National Research Council) Synthesis Study - $75,000 – Activity as outlined in attached proposal:

See next few pages....

DRAFT PROPOSAL DRAFT PROPOSAL

PROPOSAL
For a
Sustainable Development
Pilot Project
(Revision 2.0)

(OGC Interoperability Initiative Order)

~~14~~24 September 2001

Prepared for:

USAID

Prepared by:

OGC Interoperability Program Office
The Open GIS Consortium, Inc. (OGC)
12052 Willowood Drive
Woodbridge, Virginia 22192 USA
Tel: +1 703 491 9543

1/08

Sustainable Development Pilot Project

XVI. INTRODUCTION

Technologies for geospatial analysis and visualization are indispensable for understanding and communicating complex Sustainable Development issues, but lack of interoperability has limited the use of these technologies. Much of the training required for GIS, remote sensing, automated mapping, and other spatial technologies involves converting and integrating data, and much of the time spent by users of these systems is spent finding, accessing, evaluating, and combining geospatial data. These are difficult tasks because of incompatible data, and non-interoperability between types of systems and between systems from different vendors.

But recent progress in standards and open systems can directly benefit Sustainable Development programs. With user input from governments, universities and NGOs, Open GIS Consortium (OGC) industry members are cooperating in OGC's consensus standards process to create open interfaces that enable interoperability among vendors' "SCOTS" (standards-based commercial off-the-shelf) products. This effort is resulting in a much easier, web-based mode of working with spatial data. It yields greater choice in the software, services and data markets, lowers the costs of getting and using data, shortens the learning curve, and results in focused web services that can be assembled as plug and play components to address specific needs. These technology providers also have experience working together in OGC's Interoperability Program to field multivendor, interoperable solutions for the sponsors of pilot projects and other OGC Interoperability Initiatives.

The broad, long-term goal of this proposed OGC Sustainable Development Pilot Project is to involve the Sustainable Development community in OGC programs so this community can gain the greatest possible benefit from the Consortium's broad industry membership, technology development and technology transfer activities. The Pilot Project is part of more comprehensive public/private partnership for Sustainable Development. It is hoped that after the Project completes, managers and technologists in the Sustainable Development community will continue to work in OGC to ensure that spatial technologies take shape and find direction to serve Sustainable Development.

The specific, near term goal of the Project is to implement limited but operational commercial geospatial web services capabilities in Africa in support of field units and local users addressing Sustainable Development (SD) issues. These capabilities will reside in clients and servers – configuration-controlled commercial components – based on OpenGIS® Specifications. The infrastructure will be accessible via the Internet. It will enable sustainable development workers in Africa to operationally search, access and apply spatial information from a number of geospatial information providers accessible on the Web. Once operational, this network of interoperable services can be easily maintained and extended with additional standards-based COTS components that use open interfaces.

XVII. SUSTAINABLE DEVELOPMENT PILOT OBJECTIVE

The objective of the OGC Sustainable Development Pilot Project is to develop and implement a limited but operational interoperable technology framework for the discovery, access, rapid integration and application of critical spatial information relevant to sustainable development issues on the ground in Africa. OGC will plan and conduct a pilot project to implement a framework of interoperable standards-based commercial offerings in one to two of the four sites identified by initiative sponsors for the upcoming World Summit on Sustainable Development (scheduled for November 2002 in South Africa).

Through funding provided by the US State Department, OGC will prepare and deliver:

- A detailed Sustainable Development Pilot Plan to guide the execution of this Pilot Project. The plan shall consist of a Conceptual Architecture, Functional Requirements, Technical Architecture, Work Break Down Structure and schedule.Standards guidance to be used by the Sustainable Development Community to guide geospatial data and technology development, procurement and management programsA Sustainable Development Special Interest Group (SIG) to establish an open dialog between the sustainable development community and industry as represented by OGC's international membership of over 220 organizations.SCOPE/ TASK DEFINITION

Deliverables

The Statement of Work for this OGC Interoperability Program Initiative Order identifies and defines four Tasks to be executed by the OGC. Three of these tasks are designated for funding by the US Department of State. USAID and other sponsor funding will be applied to the fourth task, the execution of the Sustainable Development Pilot Project.

Establish a Sustainable Development Special Interest Group (To Be Funded by the US State Department)

OGC will establish a virtual, comprehensive Sustainable Development Special Interest Group (SIG) process to engage dialog between members of the Sustainable Development Community and OGC members from industry, government, and academia. The SIG will focus on the identification of community requirements for interoperable technologies to meet sustainable development needs, and will offer a forum for open dialog regarding other issues on standards. The SIG will be conducted virtually via a Sustainable Development website created as part of the www.opengis.org web site. Periodic teleconferences will be arranged, with additional SIG meetings held as part of OGC member meetings held five times each year (see the "events" area of the OGC site for specific details on OGC meeting schedules). The SIG will be open to all members of the OGC as well as to government, academic and industry members of the Sustainable Development community (e.g., active members of the Consultative Groups and CRSPs as defined by USAID).

Development of a Sustainable Development Pilot Plan (To Be Funded by the US State Department)

OGC will prepare a detailed Sustainable Development Plan to include all the necessary tasks: requirements assessment, operational architecture, technical architecture, work schedules and resources necessary to implement the SD Pilot Project over one to two of the areas as identified by USAID and the US State Department for the Geographic Information for Sustainable Development Working Group. The Plan will be developed based on the Technical Architecture provided in Annex B and will be designed to provide interoperable web services to increase the ease in which critical information from the local, regional, and international levels can be discovered, accessed and applied to address local SD issues and concerns. This approach when implemented, will provide SD users with a simpler "plug and play" capability for maintenance and updates to delivered systems as a result of using OGC interfaces.

~~services, and will~~As an option to this proposal, OGC will provide the planning and technical architecture necessary to ~~address the~~ transition the ~~of~~ DEVECOL to a web-based capability via prototype technologies that employ OGC Geospatial Fusion Services.

Development of Standards Guidance for the Sustainable Development Community (To Be Funded by US State Department)

OGC will develop and document guidelines and recommendations for use by the sustainable development community to develop, procure, and manage interoperable data and spatial applications programs. Guidelines are to be developed based on contributions by OGC member organizations, in collaboration with the Global Spatial Data Infrastructure (GSDI) initiative, and with other appropriate international standards bodies. Results of this task will be delivered as a report to sponsors.

Execute Sustainable Development Pilot Plan (To Be Funded by USAID, the US State Department, and other sponsors to be determined)

OGC will conduct a Sustainable Development Pilot Project over one or two of the four areas identified by USAID in accordance with the Pilot Plan identified above. Selection of the Pilot Sites and specific functionalities to be delivered will be determined by OGC during Pilot Planning task, with final approval and selections made through joint agreement between USAID and OGC.

The Sustainable Development Pilot shall deliver leave-behind interoperable products relevant to the needs of users, and based on interoperability specifications developed by OGC members (see B.1 Technical Architecture for details). OGC based Web Services capabilities will support on-line registration, discovery, access, and application of relevant local, regional and international geospatial data sources resident on OGC based map servers located in various locations on the Internet.

[redacted]As an option to this proposal, OGC will transition the present Development Ecology Information Service (DEVECOL) system to an open, interoperable web-based service accessible broadly on the Internet. Users will be able to access all delivered functionality from the Internet via a common browser, or via other interoperable applications delivered as part of this [redacted]

Pilot. In addition, OGC will provide on-line tools for the maintenance and update of links between the web based map and textual sources. To accomplish this goal, OGC will extend delivered Web Services capability provided under the core SD proposal to include Geospatial Fusion Services that employ OGC member developed open interfaces to support the discovery, linkage and spatial display of textual references (such as case studies and reports) via an on-line, web accessible map display over a region of interest in Africa.

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The OGC Interoperability Team Approach

OGC will plan and conduct the Sustainable Development Pilot in accordance with established Interoperability Program processes:

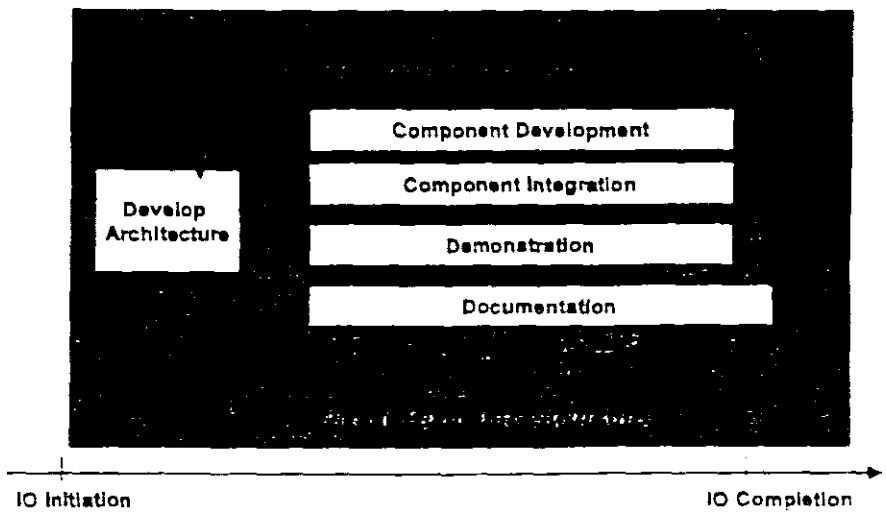

Figure 1: Sustainable Development Pilot Project Tasks

Initiative Order Coordination

OGC shall coordinate between the Pilot Project Participants[4] and the Pilot Project Sponsors that provide the requirements and funding for this initiative. See Annex C.

Develop Architecture

From the beginning of the project, OGC shall work with vendors (component developers) and with USAID and other sponsors to ensure that the sponsors' technical requirements guide the development of infrastructure and the choice, development, and use of component products. Annex B provides a draft Technical Architecture overview and set of components based on presumed requirements.

Component Development

OGC will work with vendors to ensure that they deliver the software, technical support, training, software documentation and maintenance specified in the Pilot Project Plan. OGC shall recognize that successful implementation involves a thorough understanding of the user needs and requirements. OGC shall form a Customer Advisory Group (CAG) of potential users, contractors, and other parties to capture user requirements for developing the system. See Annex B.

Component Integration

OGC shall work with vendors (component developers and systems integrators) to ensure that the Pilot Project Plan is executed fully and that they deliver the integration support and maintenance specified in the Pilot Project Plan. OGC shall conduct Technology Integration Experiments to ensure that prototypical components and working draft specifications function as required in the Pilot Project Plan.

Demonstration

OGC shall coordinate a demonstration of the Sustainable Development Pilot Project to Sustainable Development users to highlight the utility and effectiveness of these new technologies, providing vendor support as needed.

Documentation

OGC shall prepare a report documenting the pilot project process, any problems that occurred during the pilot project, and any recommendations to simplify future pilot projects. OGC shall work with vendors and systems integrators to document the configuration of components in the Sustainable Development Pilot Project Installation.

---

[4] **Participants** are technology provider organizations that contribute to the creation of interfaces and prototypes, and who provide other engineering support for an OGC Interoperability Initiative.

and develop a User's Guides in HTML format for the system to be deployed on OGC Network to assist users in system operation.

XIX. PERIOD OF PERFORMANCE

The period of performance shall commence from award date and will be completed by September 2002 unless an extension is granted in writing by both parties.

XX. US GOVERNMENT PARTICIPATION

This proposal is contingent upon Government commitment:

1. for payment of all travel related costs for OGC staff or its members to conduct requirements analysis and implementation related to the Sustainable Development Pilot Project initiative.
2. for access to all Geospatial Information required to execute the Project including access to publicly releasable government information available on Internet.
3. to assist OGC in coordination with applicable organizations involved in the project areas defined by USAID for this Pilot Project

1. for access to Government Facilities as required to support OGC member assessment of requirements in the targeted focus areas and OGC member implementation of Sustainable Development Pilot Project pilot capabilities.

XXI. SCHEDULE

SDI Pilot Project Plan by December 2001
SDI Pilot Project RFQ Release by January 2002
Sustainable Development SIG established by Feb 28, 2002
SDI Pilot Project RFQ Response by February 15, 2002
SDI Pilot Project Kick Off March 15, 2002
[redacted]
Pilot Demonstration by July 15, 2002
Standards Guidance Documentation by July 30, 2002
[redacted]
Final System Certification and Wrap-up by September 31, 2002.

The Option to exercise DEVECOL to a web based capability must be exercised by June 2002, with a completion of the task no later than 31 October 2002.

XXII. COST ESTIMATE

A Cost Estimate for this Statement of Work is included as Annex A. USAID, the US State Department, and other potential sponsors shall provide funds to OGC to offset costs of this OGC Interoperability Initiative.

USAID Funding

USAID funding (see agency allocations in Annex A) shall be applied directly for execution of the Pilot Project as described in 3.1.4 above.

US State Department Funding

Annex A also identifies funding that shall be applied by State Department funding for tasks 3.1.1 through 3.1.3. These additional tasks establish the processes for the Public Private Partnership through the OGC Technical Committee, document standards guidance for use by the sustainable development community, and support critical Pilot Project Planning.

Additional Funding Sources

OGC is pursuing remaining funding for this initiative from other government and industry sources.

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XXIII. POINTS OF CONTACT

Technical Point of Contact for the US State Department:
XXXX (XXXX, +1 202 XXX XXXX)

Technical Point of Contact for USAID:
XXXX (XXXX, +1 202 XXX XXXX)

Technical Point of Contact for OpenGIS Consortium:
Jeff Harrison (mailto:jharrison@opengis.org, +1 703 628-8655).

Business Point of Contact for US Department of State:
XXXX (XXXX, +1 202 XXX XXXX)

Business Point of Contact for USAID:
XXXX (XXXX, +1 202 XXX XXXX)

Business Point of Contact for OGC:
Marilyn Gallant (mgallant@opengis.org, +1 508 647 9385).

This proposal shall take effect as an instrument under seal.

US Agency for International Development:	OPEN GIS CONSORTIUM, INC:
BY: _____	BY: _____
NAME: _____	NAME: _____
TITLE: _____	TITLE: _____
DATE: _____	DATE: _____

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ANNEX B: TECHNICAL ARCHITECTURE AND COMPONENTS

B.1 Technical Architecture

OGC will design, develop, and maintain the Technical Architecture for the Sustainable Development Interoperable Technology Framework. The Technical Architecture shall define an open technology framework that provides on-line discovery, access, dissemination, and visualization of web-resident Geospatial Information (GI) and geoprocessing services from multiple local, regional, and international sites. The Technical Architecture will also include geospatial fusion capabilities designed to search, flag and link digital text information containing relevant spatial information into a dynamic and interactive map.

This framework shall be implemented using products that implement approved OpenGIS Specifications, along with products that implement pre-specification, pre-conformant OpenGIS geospatial fusion and web mapping specifications. These Standards-based Commercial-off-the-Shelf (SCOTS) software components will be supplied from multiple vendors chosen through Sponsors' review and selection of vendors' proposals. The Technical Architecture shall include the following components:

Component Type	Description
Services Registry	A middle tier component that contains a list of services, the metadata that describes the services and the parameters and attributes that are required for invoking, chaining or directly accessing the services across common interfaces.
Catalog Server	A middle tier component that can communicate with any client across a common interface and has been interfaced into a services metadata repository providing the capability to directly access multiple repository tier services across common interfaces.
Viewer Client (s) (Part of Visualization Operator)	A client tier set of Web pages transferred across a network, software modules transferred across a network and executed on a local system, or classes (executable code) residing on a local system for providing Map views from multiple sources. Displays and navigates Geolinks in Map View. Provides capability for user-defined symbology.
Web Map Server (WMS)	A component that delivers layers of symbolized graphics (in multiple formats) across a common interface.
Cascading Map Server (part of WMS)	A repository tier component that dynamically transforms information from other WMS-compliant servers (map and data). Can transform map layers from third-party map servers into a number of different projections and image formats, even if those map servers cannot serve those projections and formats themselves.
Web Feature Server (WFS) - Transactional	A component that delivers feature collections across a common interface (typically as the result of a query).

Register Services Client (part of Discovery Operator)	A user interaction tier set of Web pages with input fields for collecting and submitting service identifiers (among other possible information) across a common interface.
Discovery Client (part of Discovery Operator)	A Client tier set of Web pages transferred across a network, software modules transferred across a network and executed on a local system, or classes (executable code) residing on a local system for collecting and submitting user input for querying metadata across a common interface, selecting a service, and adding the service to any Client tier service as appropriate. The query screen may have three parts in which text, keyword, and geographic constraints can be defined by the analyst.
Web Client Generator (part of Visualization Operator)	A component that provides server-side processing of client-generated requests and returns responses as Web Pages.
Geospatial Fusion Services	Service components that provide the ability to parse text, match relevant spatial references via a Gazetteer, and geocode that information into a dynamic map space. A Location Organizer Folder capability will be used to capture and maintain this information for access on the web.

The architecture will also include Sponsor-provided Use Case diagrams that define the functional descriptions of the system to be developed and its major processes (Functional Specification). OGC will refine the Use Cases by working with the sponsor.

B.2 The Sustainable Development Interoperable Technology Framework

OGC members participating in the Sustainable Development Pilot Project initiative shall develop, validate and integrate a framework of interoperable services to address the use cases developed for 1 or 2 target areas defined in the WSSD project document. Implementations shall include a multi-vendor framework comprised of some of the following components:

1. **Middle and Client-Tier Components** — A possible functional model for the Sustainable Development Pilot Project might include three high-level Use Cases, centered on "Operators" that define sets of interactions that users have with information from multiple sources.
   - **Discover Operators** - allow users to search and view metadata on information sources relevant to sustainable development issues exposed as OGC Web Services and select services. Allows Service Providers to register services and maintain metadata.
   - **Fusion Operators** - allow users to process, organize, integrate and link information to create geo-organized, geo-connected collections of sustainable development information.
   - **Visualization Operators** - allow users to view and interact with layers of symbolized graphics, feature collections, gridded data, and geolinks for information sources
2. **OGC Web Services** — Services and content protocols have been developed and tested in previous OGC testbeds and pilots. Below are six sample services.

   Geospatial and Intelligence content access services, e.g., Web Feature Service – these services support Web-enabled access to repositories of relevant spatial information, including imagery.

   Geocode, geoparse and gazetteer services – these services provide the determination of the geographic location for addresses, landmarks, places, and other textual coded location descriptors.

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Coordinate transformation services – these services provide the coordinate transformations between various geodetic and map projection coordinate systems.
Discovery services - registering and finding Web-enabled geoprocessing services and content holdings, i.e., basic service model and catalog services – these services are used to discover and provide access to services and information content.
Portrayal services, e.g., Web Map Service, Styled Layer Descriptor, and Legend – these services support the Web-based display of multi-hazard information, including user-defined symbology.
Content encoding, transport protocols, and container specifications services— e.g., Geographic Markup Language, Location Organizer Folder, Imagery Annotation, Geolink, etc.—these content specifications apply to the encoding and transport of collections of related sustainable development information content that may be exploited on Web-based applications, including text with location descriptors, as well as the links between location elements comprising the collection and links to external location-based resources on the Web.

B.3 Specification Baseline

The software components of the Sustainable Development Pilot Project will implement open protocols and interfaces to communicate and provide services to users. A current baseline set of specifications includes, but is not limited to:

Geography Markup Language 2.0

Location Organizer Folder Specification

Web Feature Server Specification

Filter Specification

Web Map Server Specification 1.1

Basic Services Model

Stateless Catalog

The Sustainable Development Pilot Project may also use these specifications:

OGC Catalog Services Interface Specification Version 1.0

XML for Imagery and Map Annotation (XIMA)

Geocoder

Geoparser

Gazetteer

Location Organizer Folder

Note: Some of these OGC technologies are currently under development within the OGC Interoperability Program. This Pilot may employ modified versions of these specifications based on ongoing consensus-based interface specification development activities.

ANNEX C: COORDINATION PROGRAM

OGC shall coordinate between the Pilot Project Participants[5] and the Pilot Project Sponsors that provide the requirements and funding for this initiative.

C.1 Coordination Subtasks

Coordination shall include the following subtasks:

C.1.1. Collaborative Environment. Provide synchronous and asynchronous communications and collaboration environments for cross-organizational, globally distributed, virtual teams working interdependently to execute sustainable development initiative activities: This includes:

C.1.2. Manage an e-mail reflector and archive on the OGC member web site for Sustainable Development Pilot Project planners, participants and sponsors.

C.1.3. Manage initiative data.

C.1.4. Coordinate meetings, virtual meetings, and teleconferences for participants and sponsors.

C.1.5. Design, develop, and host an access-restricted Project web site containing:

- Project schedule
- List of participants
- Integration experiment descriptions
- List of all project documents in a document archive
- Email archive
- Collaborative workplace with capability to exchange project materials, conduct remote whiteboard sessions, and communicate using text-based synchronous communications and asynchronous messaging.

C.1.6. Develop Work Breakdown Structure. Based on requirements assessments performed over the four target areas defined for the US State Department WSSD Project, and on use cases developed by sponsors, OGC shall define Component Development and Integration Tasks necessary to realize the OGC Sustainable Development Pilot Project Technical Architecture. This Work Breakdown Structure, when combined with the Technical Architecture and Project Schedule, constitutes the Pilot Project Plan.

C.1.7. Develop and issue a Request for Quotation (RFQ) to the vendors and evaluate the responses. USAID and other sponsors of the Sustainable Development Pilot Project initiative shall have opportunity to participate in evaluation of the RFQ responses.

C.1.8. Negotiate with vendors. OGC shall negotiate and initiate contracts with the vendors for management, operations, and architecture support, software component development, and systems integration services. OGC shall provide USAID and other sponsors with copies of the contracts.

C.1.9. Project Management. OGC shall provide Project Management services, ensuring that Initiative Order participants stay within designated budgets, that the work is progressing according to the agreed schedule, and that the tasks identified in the Statement of Work and the Pilot Project Plan are executed.

C.2 Meetings, Reviews, and Status Reports

C.2.1. A Virtual Project Initiation Meeting (Kick-off) shall take place at a USAID meeting place within ten (10) working days of award of the Task Order (TO). The purpose of this meeting shall be to ensure that all parties are in agreement with:

- Technical architecture
- Coordination requirements
- Work to be performed (Task Definitions)
- Time frame in which the work is to be completed (Schedule)
- Requirements for successfully completing the TO (Deliverables)

This meeting shall serve to reiterate the original Statement of Work (SOW) and agreed upon proposal and is not intended for the assignment of additional requirements. Task priorities will be discussed at this meeting.

C.2.2. A Bi-Weekly Status Review Meeting shall be held via teleconference and web-based collaborative workplace during the performance period. The purpose of these meetings shall be for the OGC and the vendors to convey to USAID the current status of all work in progress, to identify any problems that have the potential for impacting the original intent of the SOW (Task requirements, Schedule, or Deliverables), and to discuss draft deliverables. Either USAID or the contractor may request additional meetings at any time during the course of the Pilot Project.

C.2.3. A Bi-Weekly Punch List will be provided by the OGC to USAID. It will include the following components:

---

[5] **Participants** are technology provider organizations that contribute to the creation of interfaces and prototypes, and who provide other engineering support for an OGC Interoperability Initiative.

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- Accomplishments for the period mapped against the Work Breakdown Structure (WBS) and program schedule.
- Issues that have arisen with a prioritization of critical, important, or routine. Critical will imply that resources need to be diverted immediately to resolve the issue, important will imply that effort needs to be expended within the week to resolve the issue, and routine will imply that within the biweekly reporting period it is anticipated the matter will be resolved.
- Action Items assigned to resolve issues that have arisen, including a detailed description, suspense date, assigned personnel, and oversight personnel. The action item component will also include outcome and status of previously assigned action items for review.

C.1.4 Component Development and Integration Coordination Meetings. For Pilot Project Planning and Execution, Coordination Meetings shall be held via teleconference and web-based collaborative workplace as needed. The purpose of these meetings shall be for the OGC and vendors to coordinate component development and integration activities among participants. Meetings shall be adjusted for time zones shifts as indicated in Figure C-1.

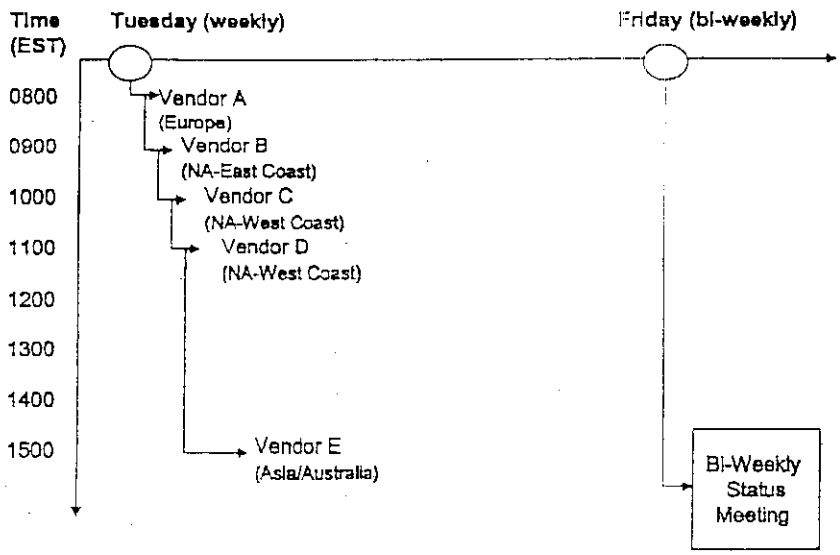

Figure C-1: Weekly Component Development and Integration Coordination Meeting Cycle (Note: NA = North America)

C.1.5. OGC shall provide a Monthly Status Report to USAID reporting the progress of the Pilot Project. It will discuss the accomplishments of WBS tasks within the reporting period, the recognition and resolution of issues, and the activities planned for the coming reporting period. In the context of the SOW and WBS deliverables received during the reporting period, it will detail integration activities that have occurred, procedural steps taken to facilitate program functions, configuration management status, and budget expenditures. This will reflect known dependencies and resource requirements for the accomplishment of period goals. Any personnel changes will be shown in light of assigned roles. A summary of relevant metrics for the period will also be attached.

Monthly Progress Reports shall be delivered to the Contracting Officer's Technical Representative (COR) or Contract Manager (CM) by the 10th business day of the month. The first monthly written Progress Report shall be delivered to the COR/CM no more than 30 days after the contract award date.

C.1.6. A Task Order (TO) Closure Meeting shall be held via teleconference on the last day of the TO period of performance. The purpose of this meeting shall be to officially end all work associated with the TO, allow the Government to take final delivery of any remaining items, and discuss the potential for follow-on activities.

Final Summary Status for the
Geographic Information For Sustainable Development
Initial Capability Pilot
Submitted by the OpenGIS Consortium
October 2002

The Open GIS Consortium (OGC) is pleased to provide a summary status for activities performed in support of the USAID / IFDC for the months of July, August, and September, 2002. This report also provides the Final Summary Status for the project. Funding from IFDC was used primarily for the execution of the Geographic Information for Sustainable Development Initial Capability Pilot (GISD-ICP), with OGC and the US Department of State incurring costs for Pilot planning.

1. ***GISD-ICP Pilot Preparation (Activities charged against State Department grant)***

Requirements Development - Initial pilot requirements were derived with the assistance of SD partners in Africa, GISD-ICP sponsors, and other principles involved in Spatial Data Infrastructure (SDI) development / promotion in Africa. This effort included attendance at two GISD Partners meetings in April, one in Asmara, Eritrea, and the other in Nairobi, Kenya,

A Request for Quotation (RFQ) was developed to solicit proposals from industry, government, NGO and academia. The RFQ contained a functional description of the interoperable technologies required to meet the GISD-ICP requirements for Sustainable Development.

The GISD-ICP RFQ was issued publicly in late March 2002. A global press release was issued, and the RFQ was made available on the OGC website.

Significant planning continued through June 2002 as OGC worked with representatives from Africa to identify additional sustainable development data, servers and applications that could be potentially integrated with the GISD-ICP over the coming months.

2. ***Pre-WSSD Demonstration GISD-ICP Pilot Execution (activities charged to IFDC contract)***

OGC received nine responses to the Request for Quotation issued as part of the planning phase for GISD_ICP. These proposals were received from companies and government organizations representing Europe, Canada and the United States.

In consultation with Sponsors (USAID, State Department, FGDC, and Natural Resources Canada), seven proposals were selected to be included in the GISD-ICP, with additional participants possible through continued interaction with African SD partners, and other interested organizations.

OGC consultants developed the GISD-ICP architecture to be used for guiding the development, installation, demonstration through early September 2002, and the maintenance of the GISD-ICP operational capability through August of 2004.

A formal Kickoff for the GISD-ICP pilot was held on May 13, 2002 with the participants selected for the GISD Pilot. The Kickoff served to introduce the participants to greater detail for each of the existing African systems, and to the international partners providing data:

- Cubewerx (Canada)
- ESRI
- Laser Scan (UK)
- Intergraph
- Advanced Technology Solutions
- Ionic (Belgium)
- Global Spatial Data Infrastructure (FGDC with SAIC)

OGC developed and gained approval of Statements of Work for each participant above. These SOWs detail the contributions of each participant to the GISD–ICP initiative, and identify delivery milestones and payment schedules.

A large number of organizations with data about Africa were contacted and agreed to make their data available via OGC interfaces for use during the demonstration at the World Summit for Sustainable Development (WSSD) in August and September. Most of them have also agreed to continue to make those data available until August 2004 as a continuing effort to build the African digital data infrastructure. Organizations that have been contacted include (black color indicates confirmed participation):

1. USGS-EDC
2. NOAA
3. NASA / CEOS
4. CIESIN
5. CARPE
6. MIOMBO
7. Tanzania CMP
8. USFS
9. FANR-RRSU
10. EIS-AFRICA
11. IERAGRHYMET
13. UNEP-DEWA
14. ESA
15. FAO Africover
16. OSS-SISEI
17. RCMRD
18. ICRAF
19. GIRC @ UCLAS
20. SAFNET
21. ICIPE
22. WWF
23. ERSS
24. CEDARESurvey / Mapping of Tanzania
26. Survey of Kenya
27. SESEI- Morocco
28. DEPHA
29. GNOSIS-GIS
30. OHVN, Mali
31. CSE Senegal
32. SISEI-Benin
33. ITC
34. OACT
35. NAFGIMIFDC

37. WRI
38. CIAT
39. WARDA
40. IWMI
41. ISNAR
42. IRRI
43. IPGRI
44. ILRI
45. IITA
46. IFPRI
47. ICLARM
48. ICARDA
49. CIP
50. CIMMYT
51. ACSAD
52. CIFOR

The computer server provided to EIS Africa was configured and shipped to Pretoria, South Africa. This computer successfully served SADC land cover data during the demonstration. The server provided to the Tanzania Coastal Management Partnership (TCMP) was configured, data were loaded and it was shipped to Dar Es Salaam, Tanzania. This computer successfully served TCMP data during the demonstration. Shipping costs for both of these computers was paid by OGC.

OGC is lead weekly teleconference meetings with participants to assure progress against goals and schedule.

3. ***WSSD Demonstration GISD-ICP Pilot Execution (activities charged to IFDC contract)***

Three personnel attended the World Summit on Sustainable Development and ran the GISD-ICP area of the U.S. display. They were Sam Bacharach of OGC staff, Yaser Bishr of Image Matters, Inc., who was under contract to OGC for this purpose, and Michelle Anthony of the USGS EROS Data Center. Ms. Anthony was provided by the Federal Geographic Data Committee at no cost to the GISD program. Mr. Bacharach arrived on 21 August for setup and was the last of them to leave, departing Johannesburg on 5 September. They operated the display daily during exposition hours at Ubuntu Village, assisted as requested with the MYCOE, and GISD areas and participated in the GISD Side Event.

4. *GISD-ICP Schedule*

Date	Milestone
15 July 2002	All Server and Client Integration Complete, SD Geodata loaded
9 August 2002	WSSD Demonstration capability tested, validated and available
16 August 2002	Training of personnel attending WSSD completed
25 August 2002	Hardware and Software installed and operational at WSSD site
26 August 2002	Demonstration Support to WSSD commences, runs through September 4
5 September 2002	Two Year operational period commences

5. ***Deliverables Summary***

Department of State, Appendix A

1. Establish a Sustainable Development Interest Group

Additionally, OGC has successfully created and continues to maintain a major website to focus the interests of Sustainable Development researchers and practitioners around the world. The site is located at www.opengis.org/gisd, and contains comprehensive information on programs, key contacts, major events, and related sustainable development links. It has become a major resource for addressing interests of sustainable development efforts. The website will continue to remain operational until it is transitioned to an appropriate organization in Africa sometime in early calendar year 2003.

2. Development of a Sustainable Development Pilot Plan
3. Development of Standards Guidance for the Sustainable Development Community

OGC has initiated a program to develop a series of implementation guides, or "cookbooks" that will be made available from OGC's website publicly to assist sustainable development practitioners and supporting information technologists to make their existing map servers and applications interoperate with other applications that employ OpenGIS specifications. These guides provide practical discussion and examples of how OpenGIS specifications can be employed to increase interoperability in an operational setting.

Guides are presently in work, with completion scheduled for Spring of 2003. These cookbooks will be made available and will be maintained via OGC's website for public download free of charge. Additionally, OGC will provide these cookbooks for inclusion in the Global Spatial Data Infrastructure (GSDI) Implementation Guide, EIS Africa Website and other interested organizations working in the area of Spatial Data Infrastructure and / or Sustainable Development.

Implementation Guides developed under this action include the OpenGIS® Web Mapping Server, Web Feature Server, and Web Coverage Server.

4. Pilot Plan Implementation

USAID, Appendix B

1. Pilot Implementation and Demonstration at WSSD

6. ***Financial***

Please see the attached Close Out 2002 Cost Summary report for detail on expenditures against plan (IFDC and DOS got separate spreadsheets)

7. ***Comments***

Post GISD-ICP planning is being conducted in concert with USAID, Mr. Robert Ford, US DOS, Mr. Fernando Echavarria, and Ms. Kate Lance, USGS. OGC has committed to writing a White Paper concerning its recommended future involvement with GISD and the UNITAR-Italian Type 2 partnership that was negotiated during the summit itself. Both of these activities are being conducted with OGC funding.

Please address questions / comments to:

Sam Bacharach
GISD-ICP Initiative Manager,
Outreach and Community Adoption
sam@opengis.org
(703) 352-3938

Mark Reichardt
Executive Director,
Outreach and Community Adoption
mreichardt@opengis.org
(301) 840-1361

Department of State Deliverables Summary, Appendix A

Task 1: Establish a Sustainable Development Interest Group
The charter of the Natural Resources and Environment Special Interest Group of the Open GIS Consortium Technical Committee has been amended to add the topic of Sustainable Development to it's work items. This change allowed five of the GISD Partners to attend the TC meeting in London, UK, last June, and also provided the framework for GISD reports and discussion at the Netherlands TC which took place in June the week following the WSSD. Sustainable Development has been accepted fully by the group and each of its members and will require no further DOS or USAID funding to continue as a work item. Of course DOS or USAID funding to enable developing world GISD partners to attend would be welcome, but that is an issue to be worked directly with the potential participants. The NRE Working Group will continue to provide a forum for dialog between sustainable development practitioners and researchers and OGC industry membership to identify critical requirements for technology interoperability.

Development of a Sustainable Development Pilot Plan
The Pilot Plan was developed, evaluated and approved in July for implementation on time to demonstrate the results at the WSSD in Johannesburg, SA.

Development of Standards Guidance for the Sustainable Development Community
OGC has initiated a program to develop a series of implementation guides, or "cookbooks" that will be made available from OGC's website publicly to assist sustainable development practitioners and supporting information technologists to make their existing map servers and applications interoperate with other applications that employ OpenGIS specifications. These guides provide practical discussion and examples of how OpenGIS specifications can be employed to increase interoperability in an operational setting.

Guides are presently in work, with completion scheduled for Spring of 2003. These cookbooks will be made available and will be maintained via OGC's website for public download free of charge. Additionally, OGC will provide these cookbooks for inclusion in the Global Spatial Data Infrastructure (GSDI) Implementation Guide, EIS Africa Website and other interested organizations working in the area of Spatial Data Infrastructure and / or Sustainable Development.

Implementation Guides developed under this action include the OpenGIS® Web Mapping Server, Web Feature Server, and Web Coverage Server.

Pilot Plan Implementation
The pilot plan was implemented and the results were demonstrated at the WSSD in Johannesburg, SA. In addition, the vendor and participant websites remain operational today and are contracted to remain so until August 31, 2004. These sites and up-to-date

information can be found at http://www.opengis.org/gisd/ and following the links to GISD-ICP.

USAID Deliverable Summary, Appendix B

The pilot plan, which was prepared with Department of State funding (see Appendix A) was implemented and the results were demonstrated at the WSSD in Johannesburg, SA. The plan itself was submitted in June and approved by USAID and DOS for implementation. In addition, the vendor and participant websites remain operational today and are contracted to remain so until August 31, 2004. These sites and up-to-date information can be found at http://www.opengis.org/gisd/ and following the links to GISD-ICP.

GISD Project
Annex 8

Subcontract With
University of Georgia (SANREM CRSP)
IFDC Contract # 01618/02

1. Project Summary Page
2. Project Memorandum of Understanding
3. Project Final Report

	Project Summary Page
MOU Lead Implementation Organization	**University of Georgia** **(SANREM CRSP)**
Contact Person	Dr. Constance Neely SANREM Management Entity 1422 Experiment Station Road Watkinsville, GA 30677-1422, USA Telephone: 706/769-8956 cneely@uga.edu
Project/Program and Statement of Work	Target Region 1: Upper Niger Basin: **GIS and Sustainable Development: Building Capacity for Measuring Carbon from Communities** The SANREM CRSP will build the capacity of collaborating Malian Scientists in Geographic Information Systems such that skills can be utilized in future SANREM-SM activities; and advance an integrated GIS database in conjunction with a carbon baseline linking previously collected data with data associated with the carbon project. A description of the activities to be undertaken by SANREM CRSP, technical procedures to be followed, deliverables required, and estimated schedule are presented in Attachment 1. Attachment 1 is incorporated as an integral part of this Memorandum of Understanding (MOU).
Collaborating Institutions	Institut d'Economic Rurale (IER), Mali
IFDC Contract Number	01618/02
Budget Amount	Signed contract with Univ of Ga for $45,000 on December 3, 2001
Amendment(s)	Draft Amendment 1 dated November 21, 2002, to Constance Neely modifies Articles 2.1 Effectives Dates of MOU and 2.2 Finance, but provides no additional funding. There is only a shift in line items on the subagreement with VA Tech.
Extension Ending Date	December 31, 2002

IFDC■0161S 02

IFDC INTERNATIONAL FERTILIZER DEVELOPMENT CENTER • MUSCLE SHOALS, ALABAMA 35662 USA
P.O. BOX 2040 • 256-381-6600
EMAIL-general@IFDC.org
TELEFAX NO. 256-381-7408

Memorandum of Understanding

Between

International Fertilizer Development Center
PO Box 2040
Muscle Shoals, AL 35662, USA

And

University of Georgia Research Foundation, Inc.
C/O SANREM
Management Entity
1422 Experiment Station Road
Watkinsville, GA 30677-1422, USA

October 1, 2001

019

IFDC-0161S 02

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C/O SANREM
Management Entity
1422 Experiment Station Road
Watkinsville, GA 30677-1422, USA

The International Fertilizer Development Center (hereinafter referred to as IFDC) is a public international organization (PIO) dedicated to increasing sustainable agricultural production through the improved use of yield enhancing technologies. The University of Georgia Research Foundation, Inc., (UGA) has submitted a proposal to USAID to support strengthening of the capacity of Malian researchers to fully participate (as equal researchers to U.S. researchers) on projects such as the recently NASA-funded project of the SANREM CRSP and the soil management CRSP related to the use of satellite imagery in estimating carbon sequestration in Mali. In order to carryout the work described herein, IFDC and the University of Georgia Research Foundation, Inc., hereinafter referred to as UGA (SANREM CRSP) hereby agree to the following terms and conditions:

1.0 INTRODUCTION AND STATEMENT OF WORK

The United States Agency for International Development (USAID) has entered into an Agreement with IFDC for IFDC to undertake a project entitled "Quick Start for Agriculture in

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Africa" to support the Geographic Information for Sustainable Development (GISD) project leading up to the World Summit on Sustainable Development (WSSD).

IFDC will provide USAID/EGAD/AFS with logistical and management support to the various partners involved in the implementation of the GISD project, including transferring and providing overall fiscal oversight to specific "pass-through" funds to selected partners who are being asked to implement specific GISD activities. This will include work already identified in specific proposals from the NRC, OGC, and several other groups located in the four Target Regions: Upper Niger Basin, African Great Lakes Region, the Kenya-Tanzania Coastal Zone, and the Limpopo/Zambeze River Basin Region of southern Africa.

IFDC will work in close collaboration with the technical officers within USAID providing oversight: Note: The Overall Coordinator is Robert E. Ford, AEMD – Agricultural Enterprise and Market Development Division within USAID's office of Agriculture and Food Security. Robert E. Ford is the Chair of the GISD-IWG for Regional Applications sub-group.

Close coordination must also occur with co-Chairs of the GISD-IWG for each sub-region. They are: Barbara Best (G/ENV) for the Kenya-Tanzania CZM Activity; Paul Bartel and Jon Anderson (AFR-SD) for the Four Corners/Limpopo/Zambezi Basin region; Robert Ford for the Great Lakes/Great Horn of Africa Region; and Mike McGahuey (USAID/AFR-SD).

UGA (SANREM CRSP) will build the capacity of collaborating Malian Scientists in Geographic Information Systems such that skills can be utilized in future SANREM-SM activities; and advance an integrated GIS database in conjunction with a carbon baseline linking previously collected data with data associated with the carbon project. A description of the activities to be undertaken by SANREM CRSP, technical procedures to be followed, deliverables required, and estimated schedule are presented in Attachment 1, which is incorporated as an integral part of this Memorandum of Understanding (MOU)

2.0 SPECIFIC CONDITIONS

2.1 Effective Dates of MOU

The effective dates of this MOU are October 1, 2001-September 30, 2002.

2.2 Finance

The work to be performed under this MOU is being financed by USAID with all funds channeled to IFDC. IFDC shall provide funding to UGA (SANREM CRSP) in accordance with the terms and conditions described in this MOU. UGA (SANREM CRSP) shall develop subagreements as necessary to support funding arrangements and the work to be performed by its collaborating institutions. The estimated funds available to UGA (SANREM CRSP) total US $45,000 (forty-five thousand) as follows:

Item	Amount US $	Total US $
Travel: 2 trips to Washington, DC	2,000	
2 Mali students from Mali to Niamey, Niger, and return	1,000	
Subtotal Travel		3,000
Operating Expenses		
a. Carbon Analysis		2,130
b. Subagreements:		
Virginia Tech:		
1 Graduate Student	9,300	
Indirect Costs (26%)	2,418	
Total Virginia Tech	11,718	
AGRHYMET:		
2 students – training costs	10,555	
Housing	1,920	
Insurance	400	
Food	3,600	
Total IER	16,455	
Subtotal Subagreements		28,203
Subtotal Travel and Operating Expenses		~~30,333~~ 33,333
UGA overhead: 35% MTDC		11,667
TOTAL		**45,000**

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2.2.1 Use of Funds

IFDC has fiduciary responsibility of funds received from USAID. Under the terms of this MOU, all funds provided to UGA (SANREM CRSP) shall be utilized solely for the purposes indicated in the budget under 2.2. Said funds shall cover all expenditures necessary for the services to be performed by and/or arranged by UGA (SANREM CRSP). IFDC shall not be responsible for any additional costs (i.e., above US $45,000) incurred in the performance of the work described under this MOU.

2.2.2 Allowable Costs

(a) UGA (SANREM CRSP) shall be reimbursed for costs incurred in carrying out the purposes of this MOU, which are reasonable, allocable, and allowable.

(b) Reasonable shall mean those costs that do not exceed those which would be incurred by an ordinarily prudent person in the conduct of normal business.

(c) Allocable shall mean those costs that are necessary to the MOU.

(d) Allowable shall mean those costs which are reasonable and allocable, and which conform to any limitations set forth in this MOU.

(e) Prior to incurring a questionable or unique cost, UGA (SANREM CRSP) is encouraged to obtain IFDC's written determination as to whether the cost will be allowable.

2.2.3 Payments

IFDC shall make payments to UGA (SANREM CRSP) subject to the receipt of funds from USAID and based upon receipt of an official invoice from UGA (SANREM CRSP). The invoice may be faxed to the official IFDC Business Contact indicated in 2.6.1. The payments shall be made on a cost reimbursable monthly basis based upon UGA (SANREM CRSP)'S submission of financial reports, which substantiate costs incurred in the performance of this MOU.

2.2.4 Financial Reports

UGA (SANREM CRSP) shall provide to IFDC, within 20 days of the end of each month under this program, a financial report indicating funds received from IFDC, and funds expended under this MOU. The financial reports shall include accounting for all allowable costs incurred by UGA (SANREM CRSP) under the program in accordance with the line item budget amounts indicated in 2.2. Copies of documentation to support all costs incurred in performance of work described in this MOU shall be provided to IFDC if requested by IFDC USAID.

2.2.5 Audit

UGA (SANREM CRSP) shall maintain books, records, documents, and other evidence in accordance with UGA (SANREM CRSP)'s usual accounting procedures to sufficiently substantiate charges to this MOU. IFDC and USAID reserve the right to examine and UGA (SANREM CRSP) agrees to make available all financial records and documents of UGA (SANREM CRSP) as related to this MOU. Any costs that are determined by either IFDC or USAID to be inconsistent with the terms and conditions of this MOU shall immediately be refunded to IFDC. UGA (SANREM CRSP) is subject to the audit guidelines and provisions of 22 CFR Section 226.26. In accordance with the provisions of OMB Circular A-133, UGA (SANREM CRSP) is obligated to comply with the requirements of OMB Circular A-133. UGA (SANREM CRSP) is required to have an audit in full compliance with the guidelines of OMB A-133 and agrees that a copy of the audit report will be submitted to IFDC's supervisor, Accounting Services, by UGA (SANREM CRSP) within thirty (30) days of completion of the audit. By the signing of this MOU, UGA (SANREM CRSP) states that they were informed of, understand, and agree to comply with the applicable compliance requirements.

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2.2.6 Refunds

(a) If UGA (SANREM CRSP) earns interest on advances under this MOU prior to expending the funds for program purposes, UGA (SANREM CRSP) shall remit the interest to IFDC or deduct the same from subsequent invoices of planned monthly expenditures in accordance with 2.2.3.

(b) Funds not disbursed to UGA (SANREM CRSP) at the time the MOU expires or is terminated shall revert to IFDC, except for such funds encumbered by UGA (SANREM CRSP) by a legally binding transaction applicable to this MOU. Any funds advanced to but not expended by UGA (SANREM CRSP) at the time of expiration or termination of the MOU shall be refunded to IFDC except for such funds encumbered by UGA (SANREM CRSP) by a legally binding transaction applicable to this MOU.

(c) If, at any time during the life of the MOU, or as a result of final audit, it is determined that funds provided under this MOU have been expended for purposes not in accordance with the terms of this MOU, UGA (SANREM CRSP) shall refund such amount to IFDC.

2.3 Language

The MOU has been executed in English, which shall be the binding and controlling language for interpretation of the terms and conditions of this MOU.

2.4 Subagreements

It is understood that UGA may carryout the work described under this MOU in collaboration with others. It is further understood that funds provided to UGA may be used to support work carried out by collaborating institutions. UGA shall ensure that the specific conditions of this MOU (i.e., Section 2.0, Specific Conditions) shall apply to all such subagreements.

2.5 Revision of MOU Budget

(a) The approved MOU budget is the financial expression of UGA (SANREM CRSP)'s program.

(b) UGA (SANREM CRSP) shall immediately request approval from IFDC when there is reason to believe that within the next 30 calendar days a revision of the approved MOU budget will be necessary for any of the following reasons:

- To change the scope or the objectives of the program and or revise the funding allocated among objectives by more than ten percent of the total budget amount unless the schedule states otherwise.
- Additional funding is needed.
- UGA (SANREM CRSP) expects the amount of authorized funds to exceed its needs by more than $5,000 or five percent of the MOU budget, whichever is greater.

(c) Except as required by other provisions of this MOU specifically stated to be an exception from this provision, IFDC shall not be obligated to reimburse UGA (SANREM CRSP) for costs incurred in excess of the total amount obligated under the MOU. UGA (SANREM CRSP) shall not be obligated to continue performance under the MOU (including actions under the "Termination Procedures" provision) or otherwise to incur costs in excess of the amount obligated under the MOU, unless and until IFDC has notified UGA (SANREM CRSP) in writing that such obligated amount has been increased and has specified the new MOU total amount.

2.6 Other Terms and Conditions

The following terms and conditions, which are applicable to the MOU by and between USAID and IFDC, shall be integral part of this Agreement.

2.6.1 Official Contacts

The contacts under this MOU for all official contacts are as follows:

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IFDC Technical
Dr. Lawrence L. Hammond
Director, Research and Development Division
IFDC
PO Box 2040
Muscle Shoals, AL 35662, USA
Telephone: 256/381-6600, extension 270
FAX: 256/381-7408
lhammond@ifdc.org
www.ifdc.org

IFDC Business
Mr. John H. Allgood
Director, Finance, Administration, and Support Services
IFDC
PO Box 2040
Muscle Shoals, AL 35662, USA
Telephone: 256/381-6600, extension 211
FAX: 256/381-7408
jallgood@ifdc.org
www.ifdc.org

UGA (SANREM CRSP) Technical/Business
Dr. Constance Neely
SANREM
Management Entity
1422 Experiment Station Road
Watkinsville, GA 30677-1422, USA
Telephone: 706/769-8956
cneely@uga.edu
www.uga.edu

Gordhan L. Patel
Executive Vice President
University of Georgia Research Foundation, Inc.
616 Boyd Graduate Studies Bldg
Athens, GA 30602-7411

2.6.2 Publications and Media Releases

If it is UGA (SANREM CRSP)'s intention to identify USAID's contribution to any publication, video or other information/media product resulting from this

MOU, UGA (SANREM CRSP) shall state that the views expressed by the author(s) do not necessarily reflect those of USAID. Acknowledgements should identify the sponsoring USAID Office and Bureau or Mission as well as USAID substantially as follows:

"This [publication, video or other information media project (specific)] was made possible through support provided by the Center for Economic Growth and Agricultural Development, Office of Agriculture and Food Security, under the terms of the MOU. The opinions expressed herein are those of the author(s) and do not necessarily reflect the views of USAID."

UGA (SANREM CRSP) shall provide the relevant strategic objective or results package team with one copy of all published works developed under this MOU and with lists of other written work produced under the MOU.

Except as otherwise provided in the terms and conditions of the MOU, the author or UGA (SANREM CRSP) is free to copyright any books, publications, or other copyrightable materials developed in the course of or under this MOU, but USAID reserves a royalty-free nonexclusive and irrevocable right to reproduce, publish, or otherwise use, and to authorize others to use the work for U.S. Government purposes.

2.6.3 Reports and Data

UGA (SANREM CRSP) shall send to the IFDC Technical Contact at the address included in this MOU, monthly and quarterly progress reports in a form and substance satisfactory to IFDC. The monthly reports will provide a brief report on the status of activities being undertaken to implement this project during the previous 30 days.

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The quarterly reports shall indicate progress toward achieving Program objectives and implementing approved work plans. The reports shall include, but not be limited to, the following information:

- Status of achievement of program goals, objectives, and benchmarks specified in the annual work plan
- Progress or completion of components, elements, or activities against planned targets
- Program description
- Other accomplishments or program highlights
- Identification and explanation of significant problems which have been encountered
- Description of planned corrective action

The monthly and quarterly reports may be submitted in electronic format and are to be delivered to IFDC within 7 calendar days and 20 calendar days, respectively, of the end of the reporting period. A final report addressing the same components included in the quarterly report is to be submitted to IFDC by UGA (SANREM CRSP) within 45 calendar days of the ending date of this MOU. The reports submitted to UGA (SANREM CRSP) to IFDC and supporting materials compiled in performing the services shall be the property of USAID.

UGA (SANREM CRSP) is also required to submit copies of reports/publications, produced within each activity as requested by the USAID Cognizant Technical Officer (e.g., workshop proceedings, PowerPoint presentations, etc.).

2.6.4 Termination

This agreement may be terminated, in whole or in part, by either party at any time upon 30 days written notice of termination. Upon receipt of and in accordance with a termination notice from the IFDC, the UGA (SANREM CRSP) shall take immediate action to cease all expenditures financed by this MOU and to cancel all

unliquidated obligations if possible. Further, upon receipt of notice of termination, the UGA (SANREM CRSP) shall not enter into any further obligations under this MOU. Except as provided below, no further reimbursement shall be made after the effective date of termination. The UGA (SANREM CRSP) shall within 30 days of the effective date of termination repay to IFDC all unexpended funds that are not otherwise obligated by a legally binding transaction applicable to this MOU. Should the funds paid by IFDC to the UGA (SANREM CRSP) prior to the effective date of termination be insufficient to cover the UGA (SANREM CRSP)'s obligations in a legally binding transaction, the UGA (SANREM CRSP) may submit to IFDC within 90 days after the effective date of termination a written claim for such amount. The IFDC shall determine the amount(s) to be paid by IFDC to the UGA (SANREM CRSP) under such claim in accordance with the "Allowable Costs" provision of this MOU.

2.6.5 Dispute Settlement

Because of the nature of this agreement and legal status of the respective organizations engaged under this MOU, reconciliation of disputes which cannot be handled amicably will be settled through discussions negotiations by and between the signatories to the MOU.

2.6.6 Investment Promotions

No funds or other support provided hereunder may be used in a program or activity reasonably likely to involve the relocation or expansion outside of the United States of an enterprise located in the United States if non-US production in such relocation or expansion replaces some or all of the production of, and reduces the number of employees at, said enterprise in the United States.

No funds or other support provided hereunder may be used in a program or activity the purpose of which is the establishment or development in a foreign country of any export processing zone or designated area where the labor,

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environmental, tax, tariff, and safety laws of the country would not apply, without the prior written approval of IFDC.

No funds or other support provided hereunder may be used in an activity which contributes to the violation of internationally recognized rights of workers in the recipient country including those in any designated zone or area in that country. This provision must be included in all subagreements.

2.6.7 Notices

Any notice given by either party under this MOU shall be sufficient only if in writing and delivered in person or faxed to the official contact persons identified in 2.5.1

2.6.8 Special Provisions

UGA (SANREM CRSP) shall comply with USAID environmental regulations (22 CFR Section 216 "Regulation 16") with respect to the activities to be undertaken under this MOU.

2.6.9 Procurement Policies and Procedures

Because USAID is the sole contributor, USAID procurement policies and procedures are applicable (22 CFR Section 226 and ADS 308.5.7a).

2.6.10 Ineligible Countries

Activities under this agreement may only be carried out in countries that are eligible to receive assistance under the Foreign Assistance Act. UGA (SANREM CRSP) shall provide IFDC in advance a list of those countries where activities are planned under this MOU.

2.6.11 Entire MOU

Unless otherwise specified, this MOU embodies the entire understanding between IFDC and UGA (SANREM CRSP) for the services to be provided and any prior to contemporaneous representations, either oral or written, are hereby superseded. No amendments or changes to this MOU, including, without limitation, changes in the statement of work, total estimated cost, and period of performance, shall be effective unless made in writing and signed by authorized representatives of the parties.

FOR AND ON BEHALF OF IFDC

By: John H Allgood

Name: JOHN H. ALLGOOD

Title: DIRECTOR OF ADMINISTRATION

Date: 12/3/01

MAB 2-1-02

FOR AND ON BEHALF OF UGA (SANREM CRSP)

By: Gordhan K Patel

Name: Gordhan K. Patel

Title: Executive Vice President

Date: FEB 18 2002

WITNESS:

By: L L Hammond

Name: LAWRENCE HAMMOND

Title: Director, R+D Division

Date: 12/3/01

WITNESS:

By: Lin Dixon

Name: LIN DIXON

Title: GRANTS OFFICER

Date: FEB 18 2002

GIS and Sustainable Development: Building Capacity for Measuring Carbon from Communities

Background

Recent international and domestic workshops have focused on the social, economic and environmental importance of terrestrial carbon sequestration and the current ability to measure and monitor carbon sinks.

Soil carbon loss is one of the prime causes of the deteriorating natural resource base in West Africa. Carbon removal through soil mining reduces soil fertility, water holding capacity, and agricultural productivity, pressing farmers to reduce or eliminate fallow and expand cultivation and grazing to more marginal areas. Agricultural systems, including cropland and grassland, can serve as a sink for soil organic carbon. Soils that have lost carbon in the process of degradation will come to a higher equilibrium of carbon stock under improved land use and management systems[1]. Critical to measuring and monitoring improved land use practices that sequester carbon will be the use of fast, cost-effective and reliable measures of soil and plant biomass carbon. Remote sensing technology can meet these requirements by providing data for input into predictive models that estimate carbon sequestration and as a tool to spatially scale up model carbon estimates over a larger area.

Recently NASA awarded a proposal submitted by the SANREM CRSP and the Soil Management CRSP related to the use of satellite imagery in estimating of carbon sequestration in Mali. The carbon sequestration proposal, named Carbon from Communities, provides an excellent opportunity to leverage SANREM CRSP and Soil Management CRSP community-based agriculture and natural resource management research experience and results for examining the possibilities for sequestrating carbon in the soils and production systems of semi-arid West Africa. The Carbon from Communities proposal aims to incorporate *in situ* measurements of biophysical conditions and crop-soil models, remote sensing technology that could provide the means for researchers and decision-makers to associate an estimated level of carbon with a particular land use practice. The Carbon from Communities project will seize a unique opportunity to simultaneously address issues of agricultural productivity, natural resource conservation and carbon sequestration working with communities in Mali.

Currently, multi-temporal imagery from the Landsat7 satellite (ETM+) has been classified to develop a land use / land cover map of the Madiama Commune in Mali. In addition, a soils map has been developed as well hydrological information. With carbon analyses on current soil samples, a carbon baseline can be developed.

To build a bridge between the current SANREM-SM CRSP activities and fast track the NASA funded carbon efforts it is important to strengthen the capacity of Malian researchers to fully participate in this projects as equal partners to USA researchers. Both the SANREM CRSP and the Soil Management CRSP have been working with very qualified Malian soil scientists who have been carrying out soil sampling and analysis but who do not have the skills to digitize, geo-reference and spatially analyze the data gathered, let alone the technical capacity to take advantage of satellite imagery to extrapolate those data. We propose to build this technical capacity and skills, while integrating and updating current data into the GIS database. Our goal is to do it via an accelerated training in GIS. Unfortunately it is not too

[1] Report from the expert workshop: "Carbon Sequestration, Sustainable Agriculture and Poverty Alleviation" held at the World Meteorological Organization (WMO) in Geneva from 8/30-9/1/2000 sponsored by the International Fund for Agricultural Development (IFAD), with support from the Food and Agriculture Organization of the United Nations (FAO) and USAID.

BEST AVAILABLE

common to have local research partners with sufficient command of English, and therefore it would not be a time- or resource-efficient proposition to invest in English training before GIS training. We therefore seek to provide GIS training in French, taking advantage of the training capacity of well-established institutions in West Africa. This effort will provide the opportunity for actual training in the use of GIS as well as the immediate application of newly acquired skills to update and consolidate information currently being developed by the CRSPs.

Objectives

The objectives of the activity outlined herewith are:

- Building the capacity of collaborating Malian Scientists in Geographic Information Systems such that skills can be utilized in future SANREM-SM activities.
- Advancing an integrated GIS database in conjunction with a carbon baseline linking previously collected data with data associated with the carbon project.

We propose to advance these objectives by:

- Training two Malian scientists from the Institut d'Economie Rurale (IER) in Geographic Information Systems. IER is a regular partner in the SANREM CRSP and Soil Management CRSP, and a key partner in the carbon sequestration project. The IER researchers selected for this training would come from the IER offices in Sotuba and Bamako. They would undergo a 2-3 month program in Burkina Faso, to take full advantage of the French-language training provided by the Centre de Systeme d'Information et de Télédétection de Ouagadougou. An alternative training site will be AGHRYMET in Niger.
- Using the capacity of the trained researchers and the technical back up of researchers in Virginia Tech, we will advance the development of remotely sensed products that combine existing and new data on land use/land cover, soils and water point location information in northern Mali. By assessing carbon baseline in existing field samples, this will be incorporated into the GIS.

Expected Outcomes

The expected outcome of this activity will be as follows:

- Two Malian scientists trained in GIS and capable of mapping the soil carbon existing information and supporting IER GIS activities in general.
- A prepared database fully prepared to capture future data associated with the NASA proposal.

This will permit the full use of remotely sensed information in the development of project-related outputs and will contribute to the World Summit on Sustainable Development in September 2002. By utilizing remotely sensed imagery to inventory and monitor carbon sequestration in degraded West African soils, this project has the potential to have a substantial positive impact toward alleviating poverty and improving food security in the region.

DRAFT PROPOSAL DRAFT PROPOSAL

SANREM CRSP: "Jumpstart for the Carbon for Communities" Activity:

GIS and Sustainable Development: Building Capacity for Measuring Carbon from Communities

Background

Recent international and domestic workshops have focused on the social, economic and environmental importance of terrestrial carbon sequestration and the current ability to measure and monitor carbon sinks.

Soil carbon loss is one of the prime causes of the deteriorating natural resource base in West Africa. Carbon removal through soil mining reduces soil fertility, water holding capacity, and agricultural productivity, pressing farmers to reduce or eliminate fallow and expand cultivation and grazing to more marginal areas. Agricultural systems, including cropland and grassland, can serve as a sink for soil organic carbon. Soils that have lost carbon in the process of degradation will come to a higher equilibrium of carbon stock under improved land use and management systems[3]. Critical to measuring and monitoring improved land use practices that sequester carbon will be the use of fast, cost-effective and reliable measures of soil and plant biomass carbon. Remote sensing technology can meet these requirements by providing data for input into predictive models that estimate carbon sequestration and as a tool to spatially scale up model carbon estimates over a larger area.

Recently NASA awarded a proposal submitted by the SANREM CRSP and the Soil Management CRSP related to the use of satellite imagery in estimating of carbon sequestration in Mali. The carbon sequestration proposal, named Carbon from Communities, provides an excellent opportunity to leverage SANREM CRSP and Soil Management CRSP community-based agriculture and natural resource management research experience and results for examining the possibilities for sequestrating carbon in the soils and production systems of semi-arid West Africa. The Carbon from Communities proposal aims to incorporate *in situ* measurements of biophysical conditions and crop-soil models, remote sensing technology that could provide the means for researchers and decision-makers to associate an estimated level of carbon with a particular land use practice. The Carbon from Communities project will seize a unique opportunity to simultaneously address issues of agricultural productivity, natural resource conservation and carbon sequestration working with communities in Mali.

Currently, multi-temporal imagery from the Landsat7 satellite (ETM+) has been classified to develop a land use / land cover map of the Madiama Commune in Mali. In addition, a soils map has been developed as well hydrological information. With carbon analyses on current soil samples, a carbon baseline can be developed.

To build a bridge between the current SANREM-SM CRSP activities and fast track the NASA funded carbon efforts it is important to strengthen the capacity of Malian researchers to fully participate in this projects as equal partners to USA researchers. Both the SANREM CRSP and the Soil Management CRSP have been working with very qualified Malian soil scientists who have been carrying out soil sampling and analysis but who do not have the skills to digitize, geo-reference and spatially analyze the data gathered, let alone the technical capacity to take advantage of satellite imagery to extrapolate those data. We propose to build this technical capacity and skills, while integrating and updating current data into the GIS database. Our goal is to do it via an accelerated training in GIS. Unfortunately it is not too common to have local research partners with sufficient command of English, and therefore it would not be a time- or resource-efficient proposition to invest in English training before GIS training. We therefore seek to provide GIS training in French, taking advantage of the training capacity of well-established

[3] Report from the expert workshop: "Carbon Sequestration, Sustainable Agriculture and Poverty Alleviation" held at the World Meteorological Organization (WMO) in Geneva from 8/30-9/1/2000 sponsored by the International Fund for Agricultural Development (IFAD), with support from the Food and Agriculture Organization of the United Nations (FAO) and USAID.

institutions in West Africa. This effort will provide the opportunity for actual training in the use of GIS as well as the immediate application of newly acquired skills to update and consolidate information currently being developed by the CRSPs.

Objectives

The objectives of the activity outlined herewith are:

- Building the capacity of collaborating Malian Scientists in Geographic Information Systems such that skills can be utilized in future SANREM-SM activities.
- Advancing an integrated GIS database in conjunction with a carbon baseline linking previously collected data with data associated with the carbon project.

We propose to advance these objectives by:

- Training two Malian scientists from the Institut d'Economie Rurale (IER) in Geographic Information Systems. IER is a regular partner in the SANREM CRSP and Soil Management CRSP, and a key partner in the carbon sequestration project. The IER researchers selected for this training would come from the IER offices in Sotuba and Bamako. They would undergo a 2-3 month program in Burkina Faso, to take full advantage of the French-language training provided by the Centre de Systeme d'Information et de Télédétection de Ouagadougou. An alternative training site will be AGHRYMET in Niger.
- Using the capacity of the trained researchers and the technical back up of researchers in Virginia Tech, we will advance the development of remotely sensed products that combine existing and new data on land use/land cover, soils and water point location information in northern Mali. By assessing carbon baseline in existing field samples, this will be incorporated into the GIS.

Expected Outcomes

The expected outcome of this activity will be as follows:

- Two Malian scientists trained in GIS and capable of mapping the soil carbon existing information and supporting IER GIS activities in general.
- A prepared database fully prepared to capture future data associated with the NASA proposal.

This will permit the full use of remotely sensed information in the development of project-related outputs and will contribute to the World Summit on Sustainable Development in September 2002. By utilizing remotely sensed imagery to inventory and monitor carbon sequestration in degraded West African soils, this project has the potential to have a substantial positive impact toward alleviating poverty and improving food security in the region.

ILLUSTRATIVE Budget

Training of Malian Scientists in Niger or Burkina Faso -	$20000	
Carbon Analysis to incorporated carbon baseline into the GIS -	$4000	
GIS backstopping to link previous data with new project data -	$9300	
Indirect Costs		$11700
Total Costs		**$45000**

(Final budget is dependent on contractual arrangements, e.g. transfer to an existing Cooperative Agreement between USAID/AFS and the SANREM CRSP)

IFDC INTERNATIONAL FERTILIZER DEVELOPMENT CENTER • MUSCLE SHOALS, ALABAMA 35662 USA
P.O. BOX 2040 • 256-381-6600
EMAIL-general@IFDC.org
TELEFAX NO. 256-381-7408

November 22, 2002

Dr. Constance Neely
SANREM
Management Entity
1422 Experiment Station Road
Watkinsville, GA 30677-1422

Dear Dr. Neely:

Amendment Number 1 to MOU between the International Fertilizer Development Center (IFDC) and the University of Georgia Research Foundation, Inc.

This letter shall serve as Amendment Number 1 to the Memorandum of Understanding between IFDC and the University of Georgia Research Foundation, Inc., to support the Geographic Information for Sustainable Development (GISD) project. The parties to the MOU agree that articles **2.1 Effective Dates of the MOU** and **2.2 Finance** are hereby changed as follows:

2.1 Effective Dates of the MOU

The effective dates of this MOU are October 1, 2001 – December 31, 2002.

2.2 Finance

The work to be performed under this MOU is being financed by USAID with all funds channeled to IFDC. IFDC shall provide funding to UGA (SANREM CRSP) in accordance with the terms and conditions described in this MOU. UGA (SANREM CRSP) shall develop subagreements as necessary to support funding arrangements and the work to be performed by its collaborating institutions. The estimated funds available to UGA (SANREM CRSP) total US $45,000 (forty-five thousand) as follows:

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Dr. Constance Neely
November 22, 2002

Item	*Amount* US $	Total US $
Travel: 2 trips to Washington, DC	2,000	
2 Mali students from Mali to Niamey, Niger, and return	1,000	
Subtotal Travel		3,000
Operating Expenses		
a. Carbon Analysis		2,130
b. Subagreements:		
Virginia Tech:		
Wages	1,500	
Materials and Supplies	1,850	
Continuous Charges	27	
Travel	5,923	
Indirect Costs (26%)	2,418	
Total Virginia Tech	11,718	
AGRHYMET:		
2 students – training costs	10,565	
Housing	1,920	
Insurance	400	
Food	3,600	
Total IER	16,485	
Subtotal Subagreements		28,203
Subtotal Travel and Operating Expenses		**33,333**
UGA overhead: 35% MTDC		11,667
TOTAL		**45,000**

All other terms and conditions of the MOU by and between IFDC and University of Georgia Research Foundation, Inc., shall remain in full force and effect. If you concur, please return one signed copy to IFDC for our records.

Sincerely yours,

JH Allgood for A H Roy

Amit H. Roy
President and Chief Executive Officer

ACCEPTED AND AGREED TO:

Gordhan R Patel

University of Georgia Research Foundation, Inc.

DAB
11/27/02

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GIS and Sustainable Development:
Building Capacity for Measuring Carbon from Communities

Final Report, October 2002

Report by: Constance L. Neely

Background
The Geographic Information for Sustainable Development program offered the possibility to build a bridge with the recently awarded NASA carbon project entitled "Carbon from Communities: A Satellite View" particularly focused on strengthening the capacity of Malian researchers to fully participate in this projects as equal partners to researchers based in the United States. This effort allowed for formal training in the use of GIS and remote sensing for two colleagues from Mali while affording the opportunity for the immediate application of newly acquired skills to update and consolidate information currently being developed by the CRSPs on Carbon Sequestration.

Objectives
The objectives of the activity outlined herewith are:

- Building the capacity of collaborating Malian Scientists in Geographic Information Systems such that skills can be utilized in future SANREM-SM activities.
- Advancing an integrated GIS database in conjunction with a carbon baseline linking previously collected data with data associated with the carbon project.

Progress toward Objectives

- **Training**
  Two scientists from the Malian Institut d'Economie Rurale (IER) were trained in GIS and remote sensing through a 8-10 week program at AGRHYMET in Niamey Niger with some follow up training at the Sotuba research station in Bamako, Mali. The IER researchers selected for this training came from the IER offices in Sotuba (Mr. Abdou Ballo) and Mopti (Mohamed Sidi Mohamed Touré). Additional support for Mr. Ballo's training was undertaken by Dr. Sibiry Traoré (ICRISAT). Mr. Ballo was involved in the remote sensing data collection as described below.

- **Data Collection and Database**
  With regard to the remote sensing component, Randy Wynne (Virginia Tech) has worked with Paul Doraswamy (USDA) on the *in situ* and aerial collection of remotely-sensed data that took place in late August in Mali. In conjunction with the Carbon from Communities activities, a two-week field campaign (August 15-30, 2002) for acquistion of data was organized by the remote sensing coordinators of the NASA team. Aircraft data collection over four project sites were completed and ground references for the Landuse classification were conducted during the same period. Randy Wynne (Virginia Tech), Curt Reynolds (USDA Foreign Agricultural Service), and Abdou Ballo (IER Bamako) (as part of the remote sensing team of the

Carbon from Communities and SANREM projects) collected data at over three hundred points of known land use in late August. At each point the general land use was noted, including both crop and cropping system for agricultural fields and dominant species for the forested or brushy areas. The location of each point was identified via GPS, and one or more photos were taken to document then current conditions. These data are being used in the analysis of remotely-sensed data acquired with air- and spaceborne platforms.

The water points of the Rural Commune of Madiama, Mali (provided by Todd Crane) have been converted into an ArcView shape file. Each point is associated (by attribute tables) with the date of data collection, village, altitude, type of water source, depth of open wells, rating of water quality, available access, town uses for water, and months of useful water.

Soil types, contour lines, crop types, town limits, and other available data have been made into maps for André Dembell Dembele, Bacoro Ballo, Bouba Tokola, Drissa Traoré Madou Coulibaly, Mory Kanté, Niamato Traoré, Zan Diarra (see following attachments).

Landsat scenes of Madiama and vicinity for the dates of Nov. 28, 1999, April 20, 2000, and Oct. 29, 2000 have been imported into Imagine. Bands representing each image type (multispectral, 1, 2, 3, 4, 5, and 7; thermal, 6.1, and 6.2; and panchromatic; 8) were stacked and co-registered using Oct. 29, 2000 as the reference image.

A pastoral zone baseline sampling has been conducted in the Malian sites of Madiama and Torokoro (197 samples at 3 depths). These samples along with samples from the 2000/2001 commune wide soil survey (a total of 143 samples) have been analyzed for carbon, nitrogen, pH and CEC.

To supplement Landsat Thematic Mapper imagery acquired by the SANREM-CRSP and airborne imagery acquired by the Carbon from Communities project, purchased panchromatic and multispectral QuickBird images of the Madiama area are being used in the hierarchical analysis of land use and land cover taking place under the auspices of the Carbon from Communities project. The land use and land cover information will be useful by itself but will also be required to facilitate carbon modeling efforts which use both DSSAT-CENTURY and EPIC-CENTURY.

- **Other outputs**

Slide sets on this effort related to the GISD were prepared for the ESRI conference (July 8th-12th, 2002) and the WSSD (August 26th - September 4th, 2002).

Outcomes

Malian colleagues trained in GIS and remote sensing are invaluable to the success of the Carbon from Communities work. By utilizing remotely sensed imagery to inventory and monitor carbon sequestration associated with community land

management practices in degraded West African soils, this project has the potential to have a substantial positive impact toward alleviating poverty and improving food security in the region.

Acknowledgements
This project wishes to also extend appreciation to Paul Doraiswamy, Mamadou Doumbia, Faustin Gnoumou, Moussa Kane, Keith Moore, André Nonguierma, Carla Roncoli, Pierre Sibiry Traore, and Russ Yost for their efforts in implementing this work.

GISD Project
Annex 9

Subcontract With
Association of American Geographers (AAG)
IFDC Contract # 01626/02

1. Project Summary Page
2. Project Memorandum of Understanding
3. Project Final Report

	Project Summary Page
MOU Lead Implementation Organization	**Association of American Geographers (AAG)**
Contact Person	Dr. Douglas Richardson Director, Division of Research and Strategic Initiatives AAG 1710 Sixteenth Street NW Washington, DC 20009, USA Telephone: 202/234-1450 FAX: 202/234-2744 drichard@aag.org www.aag.org
Project/Program and Statement of Work	The Association of American Geographers (AAG) has submitted a proposal to USAID for funding to support its activities in encouraging students to use geographic methods for understanding and demonstrating how a sustainable development issue affects their community and our earth. AAG will work to implement the "**My Community, Our Earth: Geographic Learning for Sustainable Development" (MyCOE)** project to encourage students to use geographic methods for understanding and demonstrating how a sustainable development issue affects their community and our Earth. A geographic approach to analyzing sustainable development issues will allow students to see new patterns and trends, and to find solutions to the challenges facing the future of our Earth.
Collaborating Institutions	Institut d'Economic Rurale (IER), Mali
IFDC Contract Number	01626.02
Budget Amount	USAID amendment to IFDC contract for $26,500 received from USAID on March 26, 2002. Signed contract with AAG for $25,000 on March 28, 2002
Amendment(s)	Amendment 1 to Doug Richardson dated November 18, 2002, modified Article 2.1 to provide additional funds in the amount of $62,580 and also modified Article 2.2.1.
Extension Ending Date	

IFDC 01626 02

Memorandum of Understanding

Between

International Fertilizer Development Center
PO Box 2040
Muscle Shoals, AL 35662, USA

And

Association of American Geographers
1710 Sixteenth Street NW
Washington, DC 20009, USA

March 15, 2002

Memorandum of Understanding

Between

International Fertilizer Development Center
PO Box 2040
Muscle Shoals, AL 35662, USA

And

Association of American Geographers
1710 Sixteenth Street NW
Washington, DC 20009, USA

The International Fertilizer Development Center (hereinafter referred to as IFDC) is a public international organization (PIO) dedicated to increasing sustainable agricultural production through the improved use of yield enhancing technologies. The Association of American Geographers (hereinafter referred to as AAG) has submitted a proposal to USAID for funding to support its activities in encouraging students to use geographic methods for understanding and demonstrating how a sustainable development issue affects their community and our earth. IFDC and AAG hereby agree to the following terms and conditions:

1.0 INTRODUCTION AND STATEMENT OF WORK

The United States Agency for International Development (USAID) has entered into an Agreement with IFDC for IFDC to undertake a project entitled "Quick Start for Agriculture in Africa" to support the Geographic Information for Sustainable Development (GISD) project leading up to the World Summit on Sustainable Development (WSSD).

IFDC will provide USAID/EGAD/AFS with logistical and management support to the various partners involved in the implementation of the GISD project, including transferring and providing overall fiscal oversight to specific "pass-through" funds to selected partners who are being asked to implement specific GISD activities. This will include work already identified in specific proposals from the NRC, OGC, and several other groups located in the four Target

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Regions: Upper Niger Basin, African Great Lakes Region, the Kenya-Tanzania Coastal Zone, and the Limpopo/Zambeze River Basin Region of southern Africa.

IFDC will work in close collaboration with the technical officers within USAID providing oversight: Note: The Overall Coordinator is Robert E. Ford, AEMD – Agricultural Enterprise and Market Development Division within USAID's office of Agriculture and Food Security. Robert E. Ford is the Chair of the GISD-IWG for Regional Applications sub-group.

Close coordination must also occur with co-Chairs of the GISD-IWG for each sub-region. They are: Barbara Best (G/ENV) for the Kenya-Tanzania CZM Activity; Paul Bartel and Jon Anderson (AFR-SD) for the Four Corners/Limpopo/Zambezi Basin region; Robert Ford for the Great Lakes/Great Horn of Africa Region; and Mike McGahuey (USAID/AFR-SD).

AAG will work to implement the "My Community, Our Earth: Geographic Learning for Sustainable Development" (MyCOE) project. A description of the activities to be undertaken by AAG, technical procedures to be followed, deliverables required, and estimated schedule are presented in Attachment 1, which is incorporated as an integral part of this Memorandum of Understanding (MOU).

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2.0 SPECIFIC CONDITIONS

2.1 Effective Dates of MOU

The effective dates of this MOU are March 11, 2002 - September 30, 2002.

2.2 Finance

The work to be performed under this MOU is being financed by USAID with all funds channeled to IFDC. IFDC shall provide funding to AAG in accordance with the terms and conditions described in this MOU. AAG shall develop subagreements as necessary to support funding arrangements and the work to be performed by its collaborating institutions. The estimated funds available to AAG total US $25,000 as follows:

Item	Total US $
Personnel	12,000
Travel	3,000
Equipment	0
Operating Expenses	10,000
Subtotal	**25,000**
Indirect	0
TOTAL	**25,000**

2.2.1 Use of Funds

IFDC has fiduciary responsibility of funds received from USAID. Under the terms of this MOU, all funds provided to AAG shall be utilized solely for the purposes indicated in the budget under 2.2. Said funds shall cover all expenditures necessary for the services to be performed by and or arranged by AAG. IFDC shall not be responsible for any additional costs (i.e., above US $25,000) incurred in the performance of the work described under this MOU.

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2.2.2 Allowable Costs

(a) AAG shall be reimbursed for costs incurred in carrying out the purposes of this MOU, which are reasonable, allocable, and allowable.

(b) Reasonable shall mean those costs that do not exceed those which would be incurred by an ordinarily prudent person in the conduct of normal business.

(c) Allocable shall mean those costs which are necessary to the MOU.

(d) Allowable shall mean those costs which are reasonable and allocable, and which conform to any limitations set forth in this MOU.

(e) Prior to incurring a questionable or unique cost, AAG is encouraged to obtain IFDC's written determination as to whether the cost will be allowable.

2.2.3 Payments

IFDC shall make payments to AAG subject to the receipt of funds from USAID and based upon receipt of an official invoice from AAG. The invoice may be faxed to the official IFDC Business Contact indicated in 2.6.1. The payments shall be made on a monthly basis based upon AAG's submission of monthly financial reports (2.2.4 Financial Reports) which detail actual costs incurred in the performance of this MOU.

2.2.4 Financial Reports

AAG shall provide to IFDC, within 20 days of the end of each month under this program, a financial report that shall include accounting for all allowable costs incurred by AAG under the program in accordance with the line item budget amounts indicated in 2.2. Copies of documentation to support all costs incurred in performance of work described in this MOU shall be made available to IFDC upon request by USAID.

2.2.5 Audit

AAG shall maintain books, records, documents, and other evidence in accordance with AAG's usual accounting procedures to sufficiently substantiate charges to this MOU. IFDC and USAID reserve the right to examine and AAG agrees to make available all financial records and documents of AAG as related to this MOU. Any costs that are determined by either IFDC or USAID to be inconsistent with the terms and conditions of this MOU shall immediately be refunded to IFDC. AAG is subject to the audit guidelines and provisions of 22 CFR Section 226.26. In accordance with the provisions of OMB Circular A-133, AAG is obligated to comply with the requirements of OMB Circular A-133. AAG is required to have an audit in full compliance with the guidelines of OMB A-133 and agrees that a copy of the audit report will be submitted to IFDC's supervisor, Accounting Services, by AAG within thirty (30) days of completion of the audit. By the signing of this MOU, AAG states that they were informed of, understand, and agree to comply with the applicable compliance requirements.

2.2.6 Refunds

(a) If AAG earns interest on advances under this MOU prior to expending the funds for program purposes, AAG shall remit the interest to IFDC or deduct the same from subsequent invoices of planned monthly expenditures in accordance with 2.2.3.

(b) Funds not disbursed to AAG at the time the MOU expires or is terminated shall revert to IFDC, except for such funds encumbered by a legally binding transaction applicable to this MOU. Any funds advanced to but not expended by AAG at the time of expiration or termination of the MOU shall be refunded to IFDC except for such funds encumbered by a legally binding transaction applicable to this MOU.

(c) If, at any time during the life of the MOU, or as a result of final audit, it is determined that funds provided under this MOU have been expended for

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purposes not in accordance with the terms of this MOU, AAG shall refund such amount to IFDC.

2.3 Language

The MOU has been executed in English, which shall be the binding and controlling language for interpretation of the terms and conditions of this MOU.

2.4 Subagreements

It is understood that AAG may carryout the work described under this MOU in collaboration with others. It is further understood that funds provided to AAG may be used to support work carried out by collaborating institutions. AAG shall ensure that the specific conditions of this MOU (i.e., Section 2.0, Specific Conditions) shall apply to all such subagreements.

2.5 Revision of MOU Budget

(a) The approved MOU budget is the financial expression of AAG's program.

(b) AAG shall immediately request approval from IFDC when there is reason to believe that within the next 30 calendar days a revision of the approved MOU budget will be necessary for any of the following reasons:

- To change the scope or the objectives of the program and/or revise the funding allocated among objectives by more than ten percent of the total budget amount unless the schedule states otherwise.
- Additional funding is needed.
- AAG expects the amount of authorized funds to exceed its needs by more than $5,000 or five percent of the MOU budget, whichever is greater.

(c) Except as required by other provisions of this MOU specifically stated to be an exception from this provision, IFDC shall not be obligated to reimburse AAG for costs incurred in excess of the total amount obligated under the MOU. AAG shall not be obligated to continue performance under the MOU (including actions under the "Termination Procedures" provision) or otherwise

to incur costs in excess of the amount obligated under the MOU, unless and until IFDC has notified AAG in writing that such obligated amount has been increased and has specified the new MOU total amount.

2.6 Other Terms and Conditions

The following terms and conditions, which are applicable to the MOU by and between USAID and IFDC, shall be integral part of this Agreement.

2.6.1 Official Contacts

The contacts under this MOU for all official contacts are as follows:

IFDC Technical
Dr. Lawrence L. Hammond
Director, Research and Development Division
IFDC
PO Box 2040
Muscle Shoals, AL 35662, USA
Telephone: 256/381-6600, extension 270
FAX: 256/381-7408
lhammond@ifdc.org
www.ifdc.org

IFDC Business
Mr. John H. Allgood
Director, Finance, Administration, and Support Services
IFDC
PO Box 2040
Muscle Shoals, AL 35662, USA
Telephone: 256/381-6600, extension 211
FAX: 256/381-7408
jallgood@ifdc.org
www.ifdc.org

AAG Technical/Business
Dr. Douglas Richardson
Director, Division of Research and Strategic Initiatives
AAG
1710 Sixteenth Street NW
Washington, DC 20009, USA
Telephone: 202/234-1450
FAX: 202/234-2744
drichard@aag.org
www.aag.org

2.6.2 Publications and Media Releases

If it is AAG's intention to identify USAID's contribution to any publication, video or other information/media product resulting from this MOU, AAG shall state that the views expressed by the author(s) do not necessarily reflect those of USAID. Acknowledgements should identify the sponsoring USAID Office and Bureau or Mission as well as USAID substantially as follows:

"This [publication, video or other information/media project (specific)] was made possible through support provided by the Center for Economic Growth and Agricultural Development, Office of Agriculture and Food Security, under the terms of the MOU. The opinions expressed herein are those of the author(s) and do not necessarily reflect the views of USAID."

AAG shall provide the relevant strategic objective or results package team with one copy of all published works developed under this MOU and with lists of other written work produced under the MOU.

Except as otherwise provided in the terms and conditions of the MOU, AAG is free to copyright any books, publications, or other copyrightable materials developed in the course of or under this MOU, but USAID reserves a royalty-free nonexclusive and irrevocable right to reproduce, publish, or otherwise use, and to authorize others to use the work for U.S. Government purposes.

2.6.3 Reports and Data

AAG shall send to the IFDC Technical Contact at the address included in this MOU, monthly and quarterly progress reports in a form and substance satisfactory to IFDC. The monthly reports will provide a brief report on the status of activities being undertaken to implement this project during the previous 30 days.

The quarterly reports shall indicate progress toward achieving Program objectives and implementing approved work plans. The reports shall include, but not be limited to, the following information:

- Status of achievement of program goals, objectives, and benchmarks specified in the annual work plan
- Progress or completion of components, elements, or activities against planned targets
- Program description
- Other accomplishments or program highlights
- Identification and explanation of significant problems which have been encountered
- Description of planned corrective action

The monthly and quarterly reports may be submitted in electronic format and are to be delivered to IFDC within 7 calendar days and 20 calendar days, respectively, of the end of the reporting period. A final report addressing the same components included in the quarterly report is to be submitted to IFDC by AAG within 45 calendar days of the ending date of this MOU. The reports submitted to IFDC and supporting materials compiled in performing the services shall be the property of USAID.

AAG is also required to submit copies of reports publications, produced within each activity as requested by the USAID Cognizant Technical Officer (e.g., workshop proceedings, PowerPoint presentations, etc.).

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2.6.4 Termination

This agreement may be terminated, in whole or in part, by either party at any time upon 30 days written notice of termination. Upon receipt of and in accordance with a termination notice from the IFDC, AAG shall take immediate action to cease all expenditures financed by this MOU and to cancel all unliquidated obligations if possible. Further, upon receipt of notice of termination, AAG shall not enter into any further obligations under this MOU.

2.6.5 Dispute Settlement

Because of the nature of this agreement and legal status of the respective organizations engaged under this MOU, reconciliation of disputes which cannot be handled amicably will be settled under the laws of the state of Alabama. Any such settlement rendered in the state of Alabama shall be final and binding.

2.6.6 Investment Promotions

No funds or other support provided hereunder may be used in a program or activity reasonably likely to involve the relocation or expansion outside of the United States of an enterprise located in the United States if non-US production in such relocation or expansion replaces some or all of the production of, and reduces the number of employees at, said enterprise in the United States.

No funds or other support provided hereunder may be used in a program or activity the purpose of which is the establishment or development in a foreign country of any export processing zone or designated area where the labor, environmental, tax, tariff, and safety laws of the country would not apply, without the prior written approval of IFDC.

No funds or other support provided hereunder may be used in an activity which contributes to the violation of internationally recognized rights of workers in the

recipient country including those in any designated zone or area in that country. This provision must be included in all subagreements.

2.6.7 Non-Liability

IFDC does not assume liability for any third party claims for damages arising out of this MOU.

2.6.8 Notices

Any notice given by either party under this MOU shall be sufficient only if in writing and delivered in person or faxed to the official contact persons identified in 2.5.1

2.6.9 Special Provisions

AAG shall comply with USAID environmental regulations (22 CFR Section 216 "Regulation 16") with respect to the activities to be undertaken under this MOU.

2.6.10 Procurement Policies and Procedures

Because USAID is the sole contributor, USAID procurement policies and procedures are applicable (22 CFR Section 226 and ADS 308.5.7a)

2.6.11 Ineligible Countries

Activities under this agreement may only be carried out in countries that are eligible to receive assistance under the Foreign Assistance Act. AAG shall provide IFDC in advance a list of those countries where activities are planned under this MOU.

2.6.12 Entire MOU

Unless otherwise specified, this MOU embodies the entire understanding between IFDC and AAG for the services to be provided and any prior to contemporaneous representations, either oral or written, are hereby superseded. No amendments or

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changes to this MOU, including, without limitation, changes in the statement of work, total estimated cost, and period of performance, shall be effective unless made in writing and signed by authorized representatives of the parties.

FOR AND ON BEHALF OF IFDC

By: John H. Allgood

Name: JOHN H. ALLGOOD

Title: BY ~~DIRECTOR OF ADMINISTRATION~~

Date: 4-2-02

FOR AND ON BEHALF OF AAG

By: Douglas Richardson

Name: Douglas Richardson

Title: Director of Research

Date: March 15, 2002

WITNESS:

By: Amber N. Hammock

Name: Amber N. Hammock

Title: Sr. Sec/Asst. Pers. Off.

Date: April 2, 2002

WITNESS:

By: Misty Allred

Name: Misty Allred

Title: Project Coordinator

Date: March 15, 2002

ATTACHMENT 1

My Community, Our Earth:
Geographic Learning for Sustainable Development

Goal:
To encourage students to use geographic methods for understanding and demonstrating how a sustainable development issue affects their community and our Earth.

Summary:
A geographic approach to analyzing sustainable development issues will allow students to see new patterns and trends, and to find solutions to the challenges facing the future of our Earth.

Students at the high school and university level will be given tools and other materials in a resource kit, if they request one, to analyze a sustainable development theme that is important to them. They can explore this issue at the local community, watershed, district, or other geographic scale. The analysis may involve surveying, charting, mapping, and writing about the issue and focuses on using geographic analysis to find solutions for sustainability.

The results of the students' work will be submitted as a project to the "My Community, Our Earth" program. The students can use digital tools (geographic information systems – GIS) or more traditional manual methods (hand-drawn maps and charts) to complete the project. The projects will be assembled by the project organizers and prepared for display at relevant international fora, where decision makers and professionals involved with sustainable development can review the solutions that the students developed.

Objectives:
- To conduct an international student project at high school and university levels to demonstrate approaches to sustainable development
- To raise awareness internationally of the importance of geography in dealing with issues of sustainable development
- To advance geographic learning internationally, and encourage students to learn about geographic perspectives, methodologies, and technologies that can help address sustainable development problems
- To empower students to participate in, and contribute to, sustainable development solutions

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- To present results clearly with maps, images, and graphs at international events in 2002, such as the World Summit for Sustainable Development (WSSD) in Johannesburg, South Africa and on the Internet
- To demonstrate the power of geography and GIS to participants at WSSD and interested individuals world wide via the Internet and other venues

Sustainable Development Themes:

- Biodiversity
- Climate Change
- Deforestation
- Environmental Pollution
- Food Production
- Freshwater Supply
- Health and Disease
- Urbanization
- Mountain Development
- Poverty Reduction
- Rural Development

Implementation and Schedule:

- An extensive outreach effort will be directed in the early winter and spring of 2002 at high schools and universities throughout the world. This will involve many international program and organizations that have expressed interest in supporting the program.
- Schools and/or students will be asked to register by email, web, mail, or fax in order to receive a resource kit in 2002, and will be asked to submit a project in May 2002 according to a set of defined criteria.
- Completed projects will be assembled and the best projects in each sustainable development theme (e.g. health and disease, freshwater supply, etc.) will be selected for inclusion in the exhibit at WSSD and other international events during July-December 2002.
- An international panel of geography and sustainable development experts will review the submitted projects.
- The Association of American Geographers (AAG) is the non-profit fiscal agent and administrative coordinator of the My Community, Our Earth (MyCOE) project.

Current Sponsors:

- Association of American Geographers (AAG)
- National Geographic Society
- ESRI, Inc.
- United Nations Environment Programme (UNEP)
- US Department of Agriculture
- US Agency for International Development

Management Team:

- Association of American Geographers (Fiscal agent and administrative coordinator)
- National Geographic Society
- ESRI, Inc.
- United Nations Environment Programme

Timeframe:
October 2001 - December 2002

Activities and Deliverables:
Design, develop, and disseminate brochures and posters around the world regarding the My Community, Our Earth project. Develop and implement an evaluative program for the projects received. Arrange for and conduct the showcasing of selected student projects at international and US conferences and meetings, and on the World Wide Web. Coordinate the activities of the sponsors and other organizations in the conduct of the above activities. Provide copies of all brochures, posters, and other materials to USAID for use in its programs.

Contact:
Douglas Richardson, PhD
Director, Research and Strategic Initiatives
Association of American Geographers
1710 Sixteenth Street NW
Washington, DC 20009-3198
(202) 234-1450
drichard@aag.org

IFDC INTERNATIONAL FERTILIZER DEVELOPMENT CENTER • MUSCLE SHOALS, ALABAMA 35662 USA
P.O. BOX 2040 • 256-381-6600
EMAIL-general@IFDC.org
TELEFAX NO. 256-381-7408

November 18, 2002

Dr. Douglas Richardson
Director, Division of Research and Strategic Initiatives
AAG
1710 Sixteenth Street NW
Washington, DC 20009

Amendment Number 1 to MOU between International Fertilizer Development Center (IFDC) and Association of American Geographers (AAG)

IFDC and the Association of American Geographers hereby agree to following terms and conditions of Amendment 1 to the MOU dated March 15, 2002.

2.1 Finance

The work to be performed under this MOU is being financed by USAID with all funds channeled to IFDC. IFDC shall provide funding to AAG in accordance with the terms and conditions described in this MOU. AAG shall develop subagreements as necessary to support funding arrangements and the work to be performed by its collaborating institutions. The estimated funds available to AAG under this Amendment total US $62,580 as follows:

Item	Total US $
Personnel	13,420
Travel	2,652
Equipment	-
Operating Expenses	46,488
Subtotal	**62,580**
Indirect	-
TOTAL	**62,580**

The estimated total funds available to AAG (original budget amount of $25,000 plus additional amount of $62,580) shall be $86,580. The total obligated funds available to AAG total $76,580 (original obligated amount of $25,000 plus additional funds obligated in the amount of $51,580).

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Dr. Douglas Richardson
November 18, 2002

2.2.1 Use of Funds

IFDC has fiduciary responsibility of funds received from USAID. Under the terms of this MOU, all funds provided to AAG shall be utilized solely for the purposes indicated in the budget under 2.2. Said funds shall cover all expenditures necessary for the services to be performed by and/or arranged by AAG, including additional activities and support to be provided by the My Community on Earth (MyCOE) activity, specifically covering activities related to the WSSD exhibit during the period August 12-September 7, 2002. IFDC shall not be responsible for any additional costs incurred in the performance of the work described under this Amendment.

All the terms and conditions of the MOU by and between IFDC and AAG shall remain in full force and effect.

Please return one signed copy of this Amendment to IFDC.

Sincerely yours,

for A. H. Roy

Amit H. Roy
President and Chief Executive Officer

ACCEPTED AND AGREED TO:

AAG

my community, our earth

GEOGRAPHIC LEARNING
for Sustainable Development

FINAL REPORT
MyCOE/GISD Project
For IFDC and USAID

May 7, 2003

Prepared by
Association of American Geographers

NATIONAL GEOGRAPHIC SOCIETY

UNEP

USDA

Description of the overall program

The Goal of My Community, Our Earth is to encourage students to use geographic methods for understanding and demonstrating how a sustainable development issue affects their community and our Earth.

A geographic approach to analyzing sustainable development issues allows students to see new patterns and trends, and to find solutions to the challenges facing the future of our Earth. Students at the high school and university level were given tools and other materials in a resource kit to analyze a sustainable development theme that is important to them. They explored this issue at the local community, watershed, district, or other geographic scale. Their analyses involved surveying, charting, mapping, and writing about the local issues and focused on using geographic analysis to find solutions for sustainability. Teams and individuals had used either digital tools (geographic information systems – GIS) or more traditional manual methods (hand-drawn maps and charts) to complete the project.

The results of the students' work submitted as a project to the "My Community, Our Earth" program. The projects were assembled by the project organizers and prepared for display at relevant international fora, where decision makers and professionals involved with sustainable development could review the solutions that the students developed.

The history of the MyCOE effort began with a multi-institutional response to sustainable development needs prior to the World Summit for Sustainable Development (WSSD) in Johannesburg, South Africa. The project was developed with the aim of involving secondary school, college, and university students worldwide at the local level with the global ideas championed at the WSSD. Slated as followup ten years after the Rio Conference in 1992, the WSSD presented the opportunity to showcase progress made in many communities as a result of earlier environmental efforts. The MyCOE organizers desired to create an international program that would bring these themes to light in local contexts, involve youth in geographic learning, and showcase positive results to the international decision making community at the WSSD. The result was launching of the My Community, Our Earth program in 2001 with sponsorship by the IDB, National Geographic Society, United Nations Environmental Program, Association of American Geographers, Environmental Systems Research Institute, Inc., US Agency for International Development, and others. The Association of American Geographers provided administrative coordination and served as Secretariat. MyCOE was one of the first Type 2 projects accepted by the US presidential delegation to be presented at the WSSD in Johannesburg, South Africa.

Status of achieving program goals, objectives and benchmarks specified in the annual work plan

The general objectives of the MyCOE program as specified in the work plan are:

- *To conduct an international student project at high school and university levels to demonstrate approaches to sustainable development*

Projects were received from middle schools, secondary or high schools, and college/university level participants around the theme of sustainable development.

- *To raise awareness internationally of the importance of geography in dealing with issues of sustainable development*

During the 2001-2002 cycle, the MyCOE program reached out to over 2,000 schools and youth programs in 103 countries. Demonstrating the power of analyzing information geographically, the attached maps depict the correlation between the scope of the MyCOE program and where USAID missions countries and non-mission countries that may be eligible for non-presence activities are located. The beneficiaries of the MyCOE program are located in many vulnerable regions of the world where sustainable development practices are critical to achieving balance among environmental, social and economic issues. Their sustainable solutions have been acknowledged variously by international organizations, local organizations, the press, and national level government officials. For example, the Ministry of Land and Environment in Jamaica publicly acknowledged the students of Wolmer's Girls School in Kingston on GIS Day. These students had completed a MyCOE project which assessed issues related to abandoned buildings in their neighborhood, mapped out a proposed plan for urban renewal, and ultimately received additional funding to implement some of their recommendations.

- *To advance geographic learning internationally, and encourage students to learn about geographic perspectives, methodologies, and technologies that can help address sustainable development problems*

Our sponsors and partners provided resource materials and links to mentors for the design and development of student projects. More than 200 individual students and student teams from 24 countries, aided by more than 500 volunteer mentors, submitted projects to the initial My Community, Our Earth program in 2002. A number of these were selected by a panel of knowledgeable and distinguished geographers and policymakers to be showcased at many venues around the world. Students submitting top projects received various prizes (such as GPS receivers, educational materials) in addition to special recognition.

- *To empower students to participate in, and contribute to, sustainable development solutions*

The MyCOE sustainable development themes were selected from the 40-chapter programme of actions developed at the 1992 Earth Summit in Rio de Janeiro, Brazil.

These 40 chapters, referred to as "Agenda 21," were identified as the environmental and sustainable development issues that need to be addressed in the 21st century. The themes highlighted in this project are provided to foster ideas by students and institutions of higher learning. These are: Biodiversity, Climate Change, Forest Management, Energy, Environmental Pollution, Food Production, Freshwater Supply, Health and Disease, Urbanization, Mountain Development, Poverty Reduction, and Rural Development.

- *To present results clearly with maps, images, and graphs at international events in 2002, such as the World Summit for Sustainable Development (WSSD) in Johannesburg, South Africa and on the Internet*

Ten projects were selected by an evaluation committee and were prepared and displayed at the WSSD. All of the projects for which permission was obtained are showcased on the website (www.geography.org/sustainable).

- *To demonstrate the power of geography and GIS to participants at WSSD and interested individuals world wide via the Internet and other venues*

In addition to the WSSD, select projects were displayed and highlighted at the following meetings:

- USDA (Washington, DC), October 16 and November 7, 2002
- IDB (Washington, DC), November 20, 2002 (GIS Day)
- NCSE (Washington, DC), January 30-31, 2003
- AAG Annual Meeting (New Orleans), March 5-8, 2003
- IDB Annual Meeting (Milan), March 23-25, 2003
- National 4-H Conference, (Washington DC) April 2003
- UN CSD-11 Partnerships Fair Event (New York) April 29,2003

Progress or completion of components, elements or activities, against planned target

Each of the targets specified in the original workplan have been met or exceeded:

- An extensive outreach effort was directed in the early winter and spring of 2002 at high schools and universities throughout the world. This involved many international program and organizations with interests in sustainable development.
- Schools and/or students were asked to register by email, web, mail, or fax in order to receive a resource kit in 2002, and submitted project in May 2002 according to the set of defined criteria.
- Completed projects were assembled and the best projects were selected for inclusion in the exhibit at WSSD and other international events during July-December 2002.
- An international panel of geography and sustainable development experts reviewed the submitted projects.
- As Secretariat, the Association of American Geographers (AAG) served as the non-profit fiscal agent and administrative coordinator of the My Community, Our Earth (MyCOE) project.

Final deliverables

The following deliverables lists the minimum provided by the program, and exceeds that specified in the original work plan.

- Tens of thousands of My Community, Our Earth brochures and posters were designed, developed, and disseminated around the world.
- The evaluative program for the projects received was implemented, resulting in the showcasing of projects at the WSSD in Johannesburg.
- AAG and partners arranged for and conducted the showcasing of these and other selected student projects at international and US conferences and meetings, and on the World Wide Web, including at the USDA, IDB, NCSE, AAG, National 4-H and other conferences, culminating most recently in a presentation and exhibit at the UN CSD-11 Partnerships Fair Event in New York (April 29,2003).
- As Secretariat, the AAG coordinate the activities of the sponsors and other organizations in the conduct of the above activities. Partners included Inter-American Development Bank, National Geographic Society, National Oceanic and Atmospheric Administration, United Nations Environment Programme, US Department of Agriculture, US Forest Service, US Department of State, US Agency for International Development, with support from the 3M Corporation, ERDAS, and Colombia Earthscape among many other organizations.
- Copies of all brochures, posters, powerpoints, letterhead, flyers, and other materials have been provided to USAID for use in its programs.

Other accomplishments and major highlights of program implementation

In addition to the extra accomplishments mentioned above, the program has offered to leaders and the public powerful examples of geographic learning for sustainable development. Through the efforts of participants, policy makers, decision makers, professionals, and the public can learn innovative ways to address local issues of sustainability. By bringing the concepts promoted by international summits on sustainable development "down to earth," the program is positioned to inform local, regional, and national environmental policy about real issues confronting society, through the eyes of those who will bear this responsibility in the future, the next generation. Within the context of sustainable development, geographic information and geotechnologies can be used effectively to strengthen public administration, augment community institutions, and enhance democratic processes. The MyCOE program demonstrates local efforts by young people toward building more sustainable communities while it also exemplifies inter-institutional and international cooperation. Their projects serve as tangible illustrations of the potential of geographic learning for civic education and mobilization of civil society that are part of the promise of sustainable development.

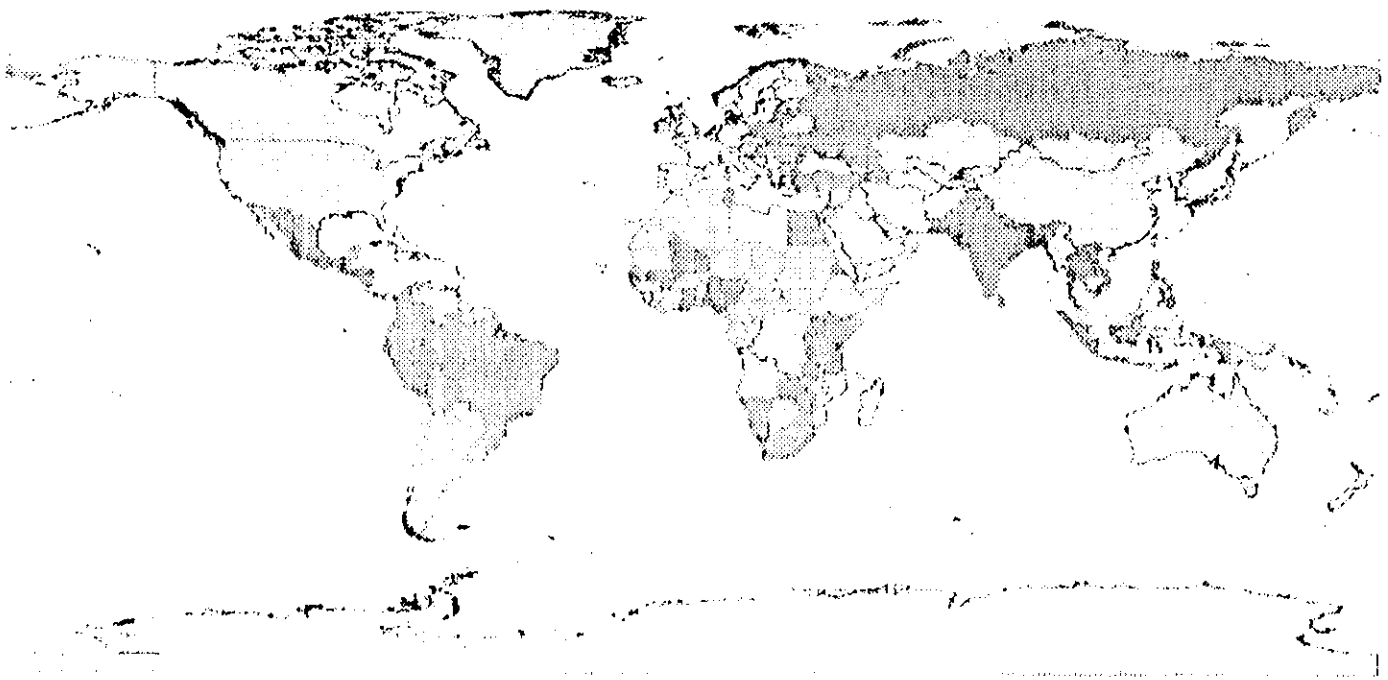
Identification and explanation of significant problems or delays related to achievement of objectives or activities.

None. All objectives were met and exceeded.

Financial report

All expenses were incurred and paid according to the amended budget of the original MOU agreement with IFDC. In addition, far more money was spent on these activities. If additional funds are available under this memorandum, we request that they be applied to unfunded needs of the MyCOE program.

Global Presence of My Community Our Earth and USAID*



Legend

- MyCOE_USAID_Missions
- MyCOE_USAID_NonMission
- No MyCOE or Non USAID Countries

* Includes non mission countries (light purple) that are eligible for non presence activities.

Map courtesy of ESRI

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GISD Project
Annex 10

Subcontract With

World Resources Institute (WRI)
IFDC Contract # 01628/02

1. Project Summary Page
2. Project Memorandum of Understanding
3. Project Final Report

	Project Summary Page
MOU Lead Implementation Organization	**World Resources Institute (WRI)**
Contact Person	Mr. Daniel B. Tunstall Director, Information Program WRI 10 G Street NE Washington, DC 20002, USA Telephone: 202/729-7788 FAX: 202/729-7775 dan@wri.org www.WRI.org
Project/Program and Statement of Work	**Environmental Information and SDI Strategies in Southern Africa.** WRI will work to implement the "Environmental Information and SDI Strategies in Southern Africa" in support of the GISD project by undertaking three activities in support of the GISD project in southern Africa. These include: Writing a geoinformation statement, workshop organization and participation in Nairobi, work with USAID staff and other southern African colleagues to prepare a synthesis paper (brochure) of the work done in the region.
Collaborating Institutions	
IFDC Contract Number	01628/02
Budget Amount	Signed contract with WRI $30,000 on March 28, 2002
Amendment(s)	None
Extension Ending Date	

IFDC 01628 02

IFDC INTERNATIONAL FERTILIZER DEVELOPMENT CENTER • MUSCLE SHOALS, ALABAMA 35662 USA
P.O. BOX 2040 • 256-381-6600
EMAIL-general@IFDC.org
TELEFAX NO. 256-381-7408

Memorandum of Understanding

Between

International Fertilizer Development Center
PO Box 2040
Muscle Shoals, AL 35662, USA

And

World Resources Institute (WRI)
10 G Street, NE
Suite 800
Washington, DC 20002, USA

March 22, 2002

INTERNATIONAL FERTILIZER DEVELOPMENT CENTER • MUSCLE SHOALS, ALABAMA 35662 USA
P.O. BOX 2040 • 256-381-6600
EMAIL-general@IFDC.org
TELEFAX NO. 256-381-7408

Memorandum of Understanding

Between

International Fertilizer Development Center
PO Box 2040
Muscle Shoals, AL 35662, USA

And

World Resources Institute (WRI)
10 G Street, NE
Suite 800
Washington, DC 20002, USA

The International Fertilizer Development Center (hereinafter referred to as IFDC) is a public international organization (PIO) dedicated to increasing sustainable agricultural production through the improved use of yield enhancing technologies. The World Resources Institute (hereinafter referred to as WRI) has submitted a proposal to USAID for funding to support its activities in Environmental Information and SDI Strategies in Southern Africa. IFDC and WRI hereby agree to the following terms and conditions:

1.0 INTRODUCTION AND STATEMENT OF WORK

The United States Agency for International Development (USAID) has entered into an Agreement with IFDC for IFDC to undertake a project entitled "Quick Start for Agriculture in Africa" to support the Geographic Information for Sustainable Development (GISD) project leading up to the World Summit on Sustainable Development (WSSD).

IFDC will provide USAID EGAD/AFS with logistical and management support to the various partners involved in the implementation of the GISD project, including transferring and providing overall fiscal oversight to specific "pass-through" funds to selected partners who are

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being asked to implement specific GISD activities. This will include work already identified in specific proposals from the NRC, OGC, and several other groups located in the four Target Regions: Upper Niger Basin, African Great Lakes Region, the Kenya-Tanzania Coastal Zone, and the Limpopo/Zambeze River Basin Region of southern Africa.

IFDC will work in close collaboration with the technical officers within USAID providing oversight: Note: The Overall Coordinator is Robert E. Ford, AEMD – Agricultural Enterprise and Market Development Division within USAID's office of Agriculture and Food Security. Robert E. Ford is the Chair of the GISD-IWG for Regional Applications sub-group.

Close coordination must also occur with co-Chairs of the GISD-IWG for each sub-region. They are: Barbara Best (G/ENV) for the Kenya-Tanzania CZM Activity; Paul Bartel and Jon Anderson (AFR-SD) for the Four Corners/Limpopo/Zambezi Basin region; Robert Ford for the Great Lakes/Great Horn of Africa Region; and Mike McGahuey (USAID/AFR-SD).

WRI will work to implement the "Environmental Information and SDI Strategies in Southern Africa" in support of the GISD project. A description of the activities to be undertaken by WRI, technical procedures to be followed, deliverables required, and estimated schedule are presented in Attachment 1, which is incorporated as an integral part of this Memorandum of Understanding (MOU).

2.0 SPECIFIC CONDITIONS

2.1 Effective Dates of MOU

The effective dates of this MOU are March 22, 2002 - September 30, 2002.

2.2 Finance

The work to be performed under this MOU is being financed by USAID with all funds channeled to IFDC. IFDC shall provide funding to WRI in accordance with the terms and conditions described in this MOU. WRI shall develop subagreements as necessary to support funding arrangements and the work to be performed by its collaborating institutions. The estimated funds available to WRI total US $30,000 as follows:

Item	Total US $
Personnel	4,245
Travel	7,100
Communications	425
Research Expenses	10,000
Subtotal	**21,770**
Indirect @ 18.07%	3,933
G & A @ 16.72%	4,297
TOTAL	**30,000**

2.2.1 Use of Funds

IFDC has fiduciary responsibility of funds received from USAID. Under the terms of this MOU, all funds provided to WRI shall be utilized solely for the purposes indicated in the budget under 2.2. Said funds shall cover all expenditures necessary for the services to be performed by and/or arranged by WRI. IFDC shall not be responsible for any additional costs (i.e., above US $30,000) incurred in the performance of the work described under this MOU.

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2.2.2 Allowable Costs

(a) WRI shall be reimbursed for costs incurred in carrying out the purposes of this MOU, which are reasonable, allocable, and allowable.

(b) Reasonable shall mean those costs that do not exceed those which would be incurred by an ordinarily prudent person in the conduct of normal business.

(c) Allocable shall mean those costs which are necessary to the MOU.

(d) Allowable shall mean those costs which are reasonable and allocable, and which conform to any limitations set forth in this MOU.

(e) Prior to incurring a questionable or unique cost, WRI is encouraged to obtain IFDC's written determination as to whether the cost will be allowable.

2.2.3 Payments

IFDC shall make payments to WRI subject to the receipt of funds from USAID and based upon receipt of an official invoice from WRI. The invoice may be faxed to the official IFDC Business Contact indicated in 2.6.1. The payments shall be made upon WRI's submission of financial reports (2.2.4 Financial Reports), which detail actual costs incurred in the performance of this MOU.

2.2.4 Financial Reports

WRI shall provide to IFDC financial reports as indicated under 2.2.3 (payments) that shall include accounting for all allowable costs incurred by WRI under the program in accordance with the line item budget amounts indicated in 2.2. Copies of documentation to support all costs incurred in performance of work described in this MOU shall be made available to IFDC upon request by USAID.

2.2.5 Audit

WRI shall maintain books, records, documents, and other evidence in accordance with WRI's usual accounting procedures to sufficiently substantiate charges to this MOU. IFDC and USAID reserve the right to examine and WRI agrees to make available all financial records and documents of WRI as related to this MOU. Any costs that are determined by either IFDC or USAID to be inconsistent with the terms and conditions of this MOU shall immediately be refunded to IFDC. WRI is subject to the audit guidelines and provisions of 22 CFR Section 226.26. In accordance with the provisions of OMB Circular A-133, WRI is obligated to comply with the requirements of OMB Circular A-133. WRI is required to have an audit in full compliance with the guidelines of OMB A-133 and agrees that a copy of the audit report will be submitted to IFDC's supervisor, Accounting Services, by WRI within thirty (30) days of completion of the audit. By the signing of this MOU, WRI states that they were informed of, understand, and agree to comply with the applicable compliance requirements.

2.2.6 Refunds

(a) If WRI earns interest on advances under this MOU prior to expending the funds for program purposes, WRI shall remit the interest to IFDC or deduct the same from subsequent invoices of planned monthly expenditures in accordance with 2.2.3.

(b) Funds not disbursed to WRI at the time the MOU expires or is terminated shall revert to IFDC, except for such funds encumbered by a legally binding transaction applicable to this MOU. Any funds advanced to but not expended by WRI at the time of expiration or termination of the MOU shall be refunded to IFDC except for such funds encumbered by a legally binding transaction applicable to this MOU.

(c) If, at any time during the life of the MOU, or as a result of final audit, it is determined that funds provided under this MOU have been expended for

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purposes not in accordance with the terms of this MOU, WRI shall refund such amount to IFDC.

2.3 Language

The MOU has been executed in English, which shall be the binding and controlling language for interpretation of the terms and conditions of this MOU.

2.4 Subagreements

It is understood that WRI may carryout the work described under this MOU in collaboration with others. It is further understood that funds provided to WRI may be used to support work carried out by collaborating institutions. WRI shall ensure that the specific conditions of this MOU (i.e., Section 2.0, Specific Conditions) shall apply to all such subagreements.

2.5 Revision of MOU Budget

(a) The approved MOU budget is the financial expression of WRI's program.

(b) WRI shall immediately request approval from IFDC when there is reason to believe that within the next 30 calendar days a revision of the approved MOU budget will be necessary for any of the following reasons:

- To change the scope or the objectives of the program and/or revise the funding allocated among objectives by more than ten percent of the total budget amount unless the schedule states otherwise.
- Additional funding is needed.
- WRI expects the amount of authorized funds to exceed its needs by more than $5,000 or five percent of the MOU budget, whichever is greater.

(c) Except as required by other provisions of this MOU specifically stated to be an exception from this provision, IFDC shall not be obligated to reimburse WRI for costs incurred in excess of the total amount obligated under the MOU. WRI shall not be obligated to continue performance under the MOU (including actions under the "Termination Procedures" provision) or otherwise

to incur costs in excess of the amount obligated under the MOU, unless and until IFDC has notified WRI in writing that such obligated amount has been increased and has specified the new MOU total amount.

2.6 Other Terms and Conditions

The following terms and conditions, which are applicable to the MOU by and between USAID and IFDC, shall be integral part of this Agreement.

2.6.1 Official Contacts

The contacts under this MOU for all official contacts are as follows:

IFDC Technical
Dr. Lawrence L. Hammond
Director, Research and Development Division
IFDC
PO Box 2040
Muscle Shoals, AL 35662, USA
Telephone: 256/381-6600, extension 270
FAX: 256/381-7408
lhammond@ifdc.org
www.ifdc.org

IFDC Business
Mr. John H. Allgood
Director, Finance, Administration, and Support Services
IFDC
PO Box 2040
Muscle Shoals, AL 35662, USA
Telephone: 256/381-6600, extension 211
FAX: 256/381-7408
jallgood@ifdc.org
www.ifdc.org

WRI Technical/Business
Mr. Daniel B. Tunstall
Director, Information Program
WRI
10 G Street NE
Washington, DC 20002, USA
Telephone: 202/729-7788
FAX: 202/729-7775
dan@wri.org
www.WRI.org

2.6.2 Publications and Media Releases

If it is WRI's intention to identify USAID's contribution to any publication, video or other information/media product resulting from this MOU, WRI shall state that the views expressed by the author(s) do not necessarily reflect those of USAID. Acknowledgements should identify the sponsoring USAID Office and Bureau or Mission as well as USAID substantially as follows:

"This [publication, video or other information/media project (specific)] was made possible through support provided by the Center for Economic Growth and Agricultural Development, Office of Agriculture and Food Security, under the terms of the MOU. The opinions expressed herein are those of the author(s) and do not necessarily reflect the views of USAID."

WRI shall provide the relevant strategic objective or results package team with one copy of all published works developed under this MOU and with lists of other written work produced under the MOU.

Except as otherwise provided in the terms and conditions of the MOU, WRI is free to copyright any books, publications, or other copyrightable materials developed in the course of or under this MOU, but USAID reserves a royalty-free nonexclusive and irrevocable right to reproduce, publish, or otherwise use, and to authorize others to use the work for U.S. Government purposes.

2.6.3 Reports and Data

WRI shall send to the IFDC Technical Contact at the address included in this MOU, monthly and quarterly progress reports in a form and substance satisfactory to IFDC. The monthly reports will provide a brief report on the status of activities being undertaken to implement this project during the previous 30 days.

The quarterly reports shall indicate progress toward achieving Program objectives and implementing approved work plans. The reports shall include, but not be limited to, the following information:

- Status of achievement of program goals, objectives, and benchmarks specified in the annual work plan
- Progress or completion of components, elements, or activities against planned targets
- Program description
- Other accomplishments or program highlights
- Identification and explanation of significant problems which have been encountered
- Description of planned corrective action

The monthly and quarterly reports may be submitted in electronic format and are to be delivered to IFDC within 7 calendar days and 20 calendar days, respectively, of the end of the reporting period. A final report addressing the same components included in the quarterly report is to be submitted to IFDC by WRI within 45 calendar days of the ending date of this MOU. The reports submitted to IFDC and supporting materials compiled in performing the services shall be the property of USAID.

WRI is also required to submit copies of reports/publications, produced within each activity as requested by the USAID Cognizant Technical Officer (e.g., workshop proceedings, PowerPoint presentations, etc.).

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2.6.4 Termination

This agreement may be terminated, in whole or in part, by either party at any time upon 30 days written notice of termination. Upon receipt of and in accordance with a termination notice from the IFDC, WRI shall take immediate action to cease all expenditures financed by this MOU and to cancel all unliquidated obligations if possible. Further, upon receipt of notice of termination, WRI shall not enter into any further obligations under this MOU.

2.6.5 Dispute Settlement

Because of the nature of this agreement and legal status of the respective organizations engaged under this MOU, reconciliation of disputes which cannot be handled amicably will be settled under the laws of the state of Alabama. Any such settlement rendered in the state of Alabama shall be final and binding.

2.6.6 Investment Promotions

No funds or other support provided hereunder may be used in a program or activity reasonably likely to involve the relocation or expansion outside of the United States of an enterprise located in the United States if non-US production in such relocation or expansion replaces some or all of the production of, and reduces the number of employees at, said enterprise in the United States.

No funds or other support provided hereunder may be used in a program or activity the purpose of which is the establishment or development in a foreign country of any export processing zone or designated area where the labor, environmental, tax, tariff, and safety laws of the country would not apply, without the prior written approval of IFDC.

No funds or other support provided hereunder may be used in an activity which contributes to the violation of internationally recognized rights of workers in the

recipient country including those in any designated zone or area in that country. This provision must be included in all subagreements.

2.6.7 Non-Liability

IFDC does not assume liability for any third party claims for damages arising out of this MOU.

2.6.8 Notices

Any notice given by either party under this MOU shall be sufficient only if in writing and delivered in person or faxed to the official contact persons identified in 2.5.1

2.6.9 Special Provisions

WRI shall comply with USAID environmental regulations (22 CFR Section 216 "Regulation 16") with respect to the activities to be undertaken under this MOU.

2.6.10 Procurement Policies and Procedures

Because USAID is the sole contributor, USAID procurement policies and procedures are applicable (22 CFR Section 226 and ADS 308.5.7a).

2.6.11 Ineligible Countries

Activities under this agreement may only be carried out in countries that are eligible to receive assistance under the Foreign Assistance Act. WRI shall provide IFDC in advance a list of those countries where activities are planned under this MOU.

2.6.12 Entire MOU

Unless otherwise specified, this MOU embodies the entire understanding between IFDC and WRI for the services to be provided and any prior to contemporaneous representations, either oral or written, are hereby superseded. No amendments or

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changes to this MOU, including, without limitation, changes in the statement of work, total estimated cost, and period of performance, shall be effective unless made in writing and signed by authorized representatives of the parties.

FOR AND ON BEHALF OF IFDC

By: BY DIRECTOR OF ADMINISTRATION

Name: JOHN H. CALLGOOD BY

Title: DIRECTOR OF ADMINISTRATION

Date: 4/11/02

FOR AND ON BEHALF OF WRI

By:

Name: Marjorie Beane

Title: VP for Admin / CFO

Date: 4/22/02

WITNESS:

By: Amber N. Hammock

Name: Amber N. Hammock

Title: Sr. Sec. / Assc. Pers. Off.

Date: April 11, 2002

WITNESS:

By: Elsie Vélez Whited

Name: Elsie Velez-Whited

Title: Director Grants Management

Date: 4/22/02

Attachment 1

Environmental Information and SDI Strategies in Southern Africa (GISD)

WRI will undertake three activities in support of the GISD project in southern Africa. These include:

1. **GEOINFORMATION STATEMENT**. WRI in collaboration with the pan-African NGO, EIS-Africa, will prepare a statement on the importance of geoinformation in the region. A white paper, tentatively entitled, Geo-information Supports Decision-Making in Africa, An EIS-Africa Position Paper, will be prepared by Elizabeth Gavin, Co-Director, EIS-Africa's Programme Committee. The paper will outline and document why geoinformation is making such an important contribution to decision-making and how this field could be expanded to do much more in the region. With a focus on building spatial data infrastructure at national level, the Statement will call for policies promoting greater public access to geo-information; investments in collection of basic digital data; implementation of geo-information standards; documentation of geo-information resources; capacity building through projects, training, and education; increased use geo-information technologies; and initiation of programs for the development of spatial data infrastructures. The statement will be published and made available on the Internet in English and French, and it will be used at the GISD southern Africa workshop, planned for April 7-13 to engage colleagues in a discussion on how to implement SDI approaches in their countries.

2. **WORKSHOP ORGANIZATION AND PARTICIPATION**. WRI and EIS-Africa colleagues will help organize the April 7-13 meeting in Nairobi for those southern African groups preparing GIS applications for presentations at WSSD. EIS-Africa Board members will assist in developing the agenda, identifying experts in the region, and providing guidance on successful GIS applications.

3. **SYNTHESIS PAPER**. EIS-Africa staff and Board will work with USAID staff and other southern African colleagues to prepare a synthesis paper (brochure) of the work done in the region, which will be presented at WSSD. This paper (brochure) will provide valuable outreach to those attending the GISD "tent" and highlight, when possible, the impact that GIS activities have had on policy- and decision-making in the region.

4. **TRAVEL TO THE REGION**. WRI staff (Dan Tunstall) will travel to Nairobi to participate in the GISD southern Africa workshop. WRI staff (Dan Tunstall) will travel to Johannesburg to participate in the WSSD.

5. **PARTICIPANT TRAVEL TO THE REGION**. WRI and EIS-Africa will arrange to pay for the travel and per diems of one or more southern African GIS experts to assist in the design and implementation of the southern African workshop and in support of GISD activities in Johannesburg, depending on funding and need.

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P.O. BOX 2040 • 256-381-6600
EMAIL-general@IFDC.org
TELEFAX NO. 256-381-7408

June 11, 2002

Mr. Daniel B. Tunstall
Director, Information Program
WRI
10 G Street NE
Washington, DC 20002

Dear Mr. Tunstall:

Amendment Number 1 to MOU between IFDC and WRI to implement the "Environmental Information and SDI Strategies in Southern Africa" in support of the GISD Project

This document will serve as Amendment 1 to the above-mentioned MOU. The parties to this MOU agree to the following modification to the above-mentioned MOU.

2.2 Finance

The work to be performed under this MOU is being financed by USAID with all funds channeled to IFDC. IFDC shall provide funding to WRI in accordance with the terms and conditions described in this MOU. WRI shall develop subagreements as necessary to support funding arrangements and the work to be performed by its collaborating institutions. The estimated funds available to WRI total US $30,000 as follows:

Direct Costs	Total US $
Salaries	10,420
Benefits (30.31%)	3,158
Research Expenses	2,500
Conference Expenses	0
Publications	0
Communications	0
Travel	5,650
Reproduction	61
Postage and Delivery Services	185
Telephone (Long Distance)	187
Miscellaneous Costs	0
Facility Costs (21.14%*)	4,685
Subtotal	26,845
G & A Expenses (14.24%*)	3,156
TOTAL BUDGET	30,000

Mr. Daniel B. Tunstall
June 11, 2002

2.6.2 Publications and Media Releases

If it is WRI's intention to identify USAID's contribution to any publication, video or other information/media product resulting from this MOU, WRI shall state that the views expressed by the author(s) do not necessarily reflect those of USAID. Acknowledgements should identify the sponsoring USAID Office and Bureau or Mission as well as USAID substantially as follows:

"This [publication, video or other information/media project (specific)] was made possible through support provided by Economic Growth Agriculture and Trade (EGAT) under the terms of the MOU. The opinions expressed herein are those of the author(s) and do not necessarily reflect the views of USAID."

WRI shall provide the relevant strategic objective or results package team with one copy of all published works developed under this MOU and with lists of other written work produced under the MOU.

Except as otherwise provided in the terms and conditions of the MOU, WRI is free to copyright any books, publications, or other copyrightable materials developed in the course of or under this MOU, but USAID reserves a royalty-free nonexclusive and irrevocable right to reproduce, publish, or otherwise use, and to authorize others to use the work for U.S. Government purposes.

All the terms and conditions of the MOU by and between IFDC and WRI shall remain in full force and effect.

Please return one signed copy of this Amendment to IFDC.

Sincerely yours,

Amit H. Roy
President and Chief Executive Officer

ACCEPTED AND AGREED TO:

WRI

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World Resources Institute

GISD Final Report for USAID and IFDC

April 12002 through September 30, 2002

WRI agreed to undertake a number of tasks in support of the Geographic Information for Sustainable Development project. Some of these tasks were modified as the project took shape. Throughout this 12 month period, WRI staff have consistently been available to work with USAID and GISD collaborators to plan and implement the project and ensure that the ideas and lessons learned from the project will be brought to bear on the future of geospatial information in Africa.

Task 1. Geoinformation Statement

WRI staff, worked closely with the pan-African NGO, EIS-Africa, to complete the preparation, peer review, revision, publication, and distribution of the geoinformation statement, entitled, "Geoinformation Supports Decision-Making in Africa: An EIS-Africa Position Paper." Elizabeth Gavin, Acting Executive Director of EIS-Africa, was the principal author.

Copies of the statement were made available on the Open GIS Website for GISD and the EIS-Africa website. The Statement is available in French and English and was presented and discussed at workshops in Bamako, Mali; Asmara, Eritrea, and Nairobi, Kenya. Furthermore, the statement was circulated electronically to experts and officials in most African countries and distributed at the July AMCEN meetings in Kampala, Uganda. It was also printed (5,000 copies in French and English) and distributed at the GISD booth in Johannesburg. And, it was referenced in the EIS-Africa electronic newsletter, EIS-News, which reached over 1,200 users directly.

The Statement was used to show the value and use of GIS and remote sensing in Africa by highlighting successful applications. It also called for greater efforts to be made by countries and the international community to develop the underlying institutional and policy structures which are needed to sustain the development and use of spatial data at country and regional levels.

The Statement had considerable influence through discussions at WSSD and from its use in policy dialogues and media outreach. It was also used in follow-up discussions in Spatial Data Infrastructure workshops with the Economic Commission for Africa and in the development of a set of guidelines on the development of SDI at country level.

We believe the Statement has had significant effect by putting the need for Spatial Data Infrastructure on the agenda within African institutions and over the next two years, we expect to considerable attention paid to this issue.

For example, at a recent workshop hosted by UNEP's Division on Early Warning and Assessment, which has the responsibility to plan and implement the African Environmental Information Network, the "Data Group" recommended that AEIN conduct rapid assessments of country's SDI capacity and plans in order to strengthen the development of core data sets and indicators, leading to the preparation of national state of environment reports, sub-regional environmental reports, and the next African Environmental Outlook.

Task 2. GISD Workshop for East and Southern Africa

WRI staff helped organize and participate in the GISD Workshop, held in Nairobi, Kenya during the week of April 8-12. WRI staff assisted by chairing sessions and preparing detailed notes and summaries of a number of the discussions.

The workshop resulted in the identification of a set of high quality case studies from the East and Southern African regions, which were displayed at WSSD. The workshop was also successful in identifying a set of guidelines for case study presenters to follow in preparing their posters and power-point presentations at WSSD. It also identified the issues that have to be addressed if geographic information is going to be used on a consistent basis to assess, plan, manage, and sustain the natural resource base and agro-ecosystems of the region. And, during the last day, we were able to identify both barriers and opportunities that GISD collaborators will have to address to sustain the GISD project into the future.

Copies of notes and materials from the workshop were made available on the GISD website.

The ideas generated from this workshop have helped to shape the future of GISD. (See Task 4.)

Task 3. Synthesis Paper

After much discussion, it was decided that WRI would not be involved in the development of the final GISD report and brochure. Instead WRI continued to participate in meetings of the GISD collaborators in Washington and later in Johannesburg.

WRI did work with USAID/Africa Bureau and IRG, Inc. to prepare two posters showing African-wide GIS-based indicators. One poster captured maps on Demographic, Infrastructure, and Governance Trends; the second poster displayed maps on Agriculture and Forest Conditions. A power-point presentation was prepared to accompany this display.

Task 4. Forum on Geospatial Information for Africa

WRI staff traveled to Johannesburg and participated in the GISD/WSSD preparations, presentations, and most notably in the development of the plans for the Forum on Geospatial Information in Africa. We helped organize and participate in numerous meetings during the two-weeks of WSSD in which the principles, partnerships, and plans for the Forum were developed. Later, we worked with EIS-Africa to develop a draft budget and with UNITAR and USAID staff to develop short term plans for meetings of the Forum.

WRI staff also worked on the draft Type II Partnership between the United States, Italy, and many other organizations. In the end, the Type II Partnership was dropped and a separate agreement between the governments of the United States and Italy was drafted. WRI staff did not participate in this final drafting of this agreement.

Task 5. Financial Assistance to African Experts to attend WSSD. WRI provided some financial support to Andre Bassole, Chairman of EIS-Africa, to attend WSSD. As all the GISD collaborators know, Andre was asked by the U.S. government to represent GISD during the one day seminar on partnerships. His presentation as a GISD collaborator was clearly the highpoint in showing that GISD was a collaboration of Africans and northern experts in geospatial information.

Final Note.

Although it was not a formal task within the GISD agreement, WRI staff have continued to support the development and follow-up of GISD activities including:

- discussions of the Forum at the EIS-Africa Annual General Meeting in Pretoria;
- attendance at the NAS/ US Government one day workshop on lessons learned at WSSD from the preparation of the "Down to Earth" study by the National Research Council and the GISD project;
- attendance at the AEIN stakeholders meeting in Pretoria; and
- attendance at the USAID Community of Practice Workshop.

It has been our intent throughout this project to bring African experience and experts to bear on the process and we believe that has been successfully achieved. Furthermore, it has been the intent of WRI to assist USAID and collaborators in planning a follow-up activity that seeks to expand the development and use of geo-spatial information in Africa. During this period of evaluation and planning we have identified a number of principles which we believe can strengthen geospatial information in Africa (and in other developing regions) and have shared these principles as foundations for US government activities and projects. These include:

- Strengthening and expanding the role of SDI at country, sub-regional, and regional levels;
- Assisting countries to compile and maintain core data bases needed to develop indicators of sustainable development;
- Development and implementation of data policies, which will help open access to information and give citizens greater opportunity to participate in decisions that affect them;
- Promote appropriate geo-spatial technologies in support of natural resource management, environmental quality, sustainable agriculture, and other key uses of geo-spatial information;
- Expand training and education through African university programs, the private sector, and international institutional support;
- Support the rapidly growing number of data networks that include Africans and assist Africans to develop the capacity to make this information available throughout the region and globally;
- Support applications of geospatial information for sustainable development and promote the development of lessons learned, best practices, and harmonized guidelines.

It is exciting to see some of these themes being captured by officials in the U.S. government and in African institutions. WRI seeks to continue this collaboration with USAID and other government agencies, the private sector, universities, NGOs, and, of course, our many colleagues in Africa.

We very much appreciate the support provided by USAID and IFDC in this project.

Dan Tunstall,
Director
Information Program
World Resources Institute
10 G St. NE
Washington D.C. 20002

GISD Project
Annex 11

Subcontract With

World Wildlife Fund, Inc. (WWF)
IFDC Contract # 01629/02

1. Project Summary Page
2. Project Memorandum of Understanding
3. Project Final Report

	Project Summary Page
MOU Lead Implementation Organization	**World Wildlife Fund, Inc. (WWF)**
Contact Person	Kate Newman Director, East and Southern Africa World Wildlife Fund/US 1250 24th Street, NW Washington, DC 20910-1175, USA Tel: 202-778-9524 Fax: 202-861-8377 kate.newman@wwfus.org
Project/Program and Statement of Work	**WWF GIS STRATEGIC SUPPORT AND ANALYSIS FOR SOUTHERN AFRICA** WWF will work to create an awareness of the value of remotely sensed data and GIS technologies as a natural resource management tool and initiate a program aimed at building capacity to allow WWF personnel and associates in southern and eastern Africa to make effective use of the technologies.
Collaborating Institutions	
IFDC Contract Number	01629 02
Budget Amount	Signed contract with WWF for $50,000 on March 27, 2002
Amendment(s)	Amendment 1 dated November 19 to Lee Zahnow modified Article 2.1 Effective Dates of MOU.
Extension Ending Date	January 31, 2003

IFDC 01619 02

IFDC INTERNATIONAL FERTILIZER DEVELOPMENT CENTER • MUSCLE SHOALS, ALABAMA 35662 USA
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TELEFAX NO. 256-381-7408

Memorandum of Understanding

Between

International Fertilizer Development Center
PO Box 2040
Muscle Shoals, AL 35662, USA

And

World Wildlife Fund, Inc. (WWF)
1250 24th Street, NW
Washington, DC 20037

January 21, 2002

IFDC INTERNATIONAL FERTILIZER DEVELOPMENT CENTER • MUSCLE SHOALS, ALABAMA 35662 USA
P.O. BOX 2040 • 256-381-6600
EMAIL-general@IFDC.org
TELEFAX NO. 256-381-7408

Memorandum of Understanding

Between

International Fertilizer Development Center
PO Box 2040
Muscle Shoals, AL 35662, USA

And

World Wildlife Fund, Inc. (WWF)
1250 24th Street, NW
Washington, DC 20037

The International Fertilizer Development Center (hereinafter referred to as IFDC) is a public international organization (PIO) dedicated to increasing sustainable agricultural production through the improved use of yield enhancing technologies. World Wide Fund for Nature has submitted a proposal to IFDC on behalf of World Wildlife Fund, Inc., in Washington, DC, to support activities aimed at enhancing GIS efforts among WWF SARPO partners and affiliates. In order to carryout the work described herein, IFDC and WWF hereby agree to the following terms and conditions:

1.0 INTRODUCTION AND STATEMENT OF WORK

The United States Agency for International Development (USAID) has entered into an Agreement with IFDC for IFDC to undertake a project entitled "Quick Start for Agriculture in Africa" to support the Geographic Information for Sustainable Development (GISD) project leading up to the World Summit on Sustainable Development (WSSD).

IFDC will provide USAID/EGAD/AFS with logistical and management support to the various partners involved in the implementation of the GISD project, including transferring and providing overall fiscal oversight to specific "pass-through" funds to selected partners who are being asked to implement specific GISD activities. This will include work already identified in

specific proposals from the NRC, OGC, and several other groups located in the four Target Regions: Upper Niger Basin, African Great Lakes Region, the Kenya-Tanzania Coastal Zone, and the Limpopo/Zambeze River Basin Region of southern Africa.

IFDC will work in close collaboration with the technical officers within USAID providing oversight: Note: The Overall Coordinator is Robert E. Ford, AEMD – Agricultural Enterprise and Market Development Division within USAID's office of Agriculture and Food Security. Robert E. Ford is the Chair of the GISD-IWG for Regional Applications sub-group.

Close coordination must also occur with co-Chairs of the GISD-IWG for each sub-region. They are: Barbara Best (G/ENV) for the Kenya-Tanzania CZM Activity; Paul Bartel and Jon Anderson (AFR-SD) for the Four Corners/Limpopo/Zambezi Basin region; Robert Ford for the Great Lakes/Great Horn of Africa Region; and Mike McGahuey (USAID/AFR-SD).

WWF will work to create an awareness of the value of remotely sensed data and GIS technologies as a natural resource management tool and initiate a program aimed at building capacity to to allow WWF personnel and associates in southern and eastern Africa to make effective use of the technologies. Background information, objectives, and a description of the activities to be undertaken by WWF are presented in Attachment 1, which is incorporated as an integral part of this Memorandum of Understanding (MOU).

2.0 SPECIFIC CONDITIONS

2.1 Effective Dates of MOU

The effective dates of this MOU are January 21-September 30,2002.

2.2 Finance

The work to be performed under this MOU is being financed by USAID with all funds channeled to IFDC. IFDC shall provide funding to WWF in accordance with the terms and conditions described in this MOU. WWF may develop subagreements as necessary to support funding arrangements and the work to be performed by its collaborating institutions. The estimated funds available to WWF total US $50,000 (fifty thousand) as follows:

Item	Total US $
Personnel	0.00
Third Party Fees & Expenses	0.00
Grant Agreements	43,497.17
Travel, Meetings, Workshop Costs	0.00
Other Direct Costs	0.00
Equipment	0.00
TOTAL DIRECT COSTS	**43,497.17**
Indirect Costs	6,502.83
TOTAL COSTS	**50,000.00**
TOTAL COST SHARE	**0.00**
TOTAL PROJECT COSTS	**50,000.00**

2.2.1 Use of Funds

IFDC has fiduciary responsibility of funds received from USAID. Under the terms of this MOU, all funds provided to WWF shall be utilized solely for the purposes indicated in the budget under 2.2. Said funds shall cover all expenditures necessary for the services to be performed by and or arranged by WWF. IFDC shall not be responsible for any additional costs (i.e., above

US $50,000 (fifty thousand)) incurred in the performance of the work described under this MOU.

2.2.2 Allowable Costs

(a) WWF shall be reimbursed for costs incurred in carrying out the purposes of this MOU, which are reasonable, allocable, and allowable.

(b) Reasonable shall mean those costs that do not exceed those which would be incurred by an ordinarily prudent person in the conduct of normal business.

(c) Allocable shall mean those costs that are necessary to the MOU.

(d) Allowable shall mean those costs which are reasonable and allocable, and which conform to any limitations set forth in this MOU.

(e) Prior to incurring a questionable or unique cost, WWF is encouraged to obtain IFDC's written determination as to whether the cost will be allowable.

2.2.3 Payments

IFDC shall make payments to WWF subject to the receipt of funds from USAID and based upon receipt of an official invoice from WWF. The invoice may be faxed to the official IFDC Business Contact indicated in 2.6.1. The payments shall be made on a cost reimbursement basis based upon WWF'S submission of financial reports, which substantiate costs incurred in the performance of this MOU.

2.2.4 Financial Reports

WWF shall provide to IFDC, within 20 days of the end of each quarter under this program, a financial report indicating funds received from IFDC and funds expended under this MOU. The financial reports shall include accounting for all allowable costs incurred by WWF under the program in accordance with the line

item budget amounts indicated in 2.2. Copies of documentation to support all costs incurred in performance of work described in this MOU shall be sent to IFDC upon request by IFDC/USAID.

2.2.5 Audit

WWF shall maintain books, records, documents, and other evidence in accordance with WWF's usual accounting procedures to sufficiently substantiate charges to this MOU. IFDC and USAID reserve the right to examine and WWF agrees to make available all financial records and documents of WWF as related to this MOU. Any costs that are determined by either IFDC or USAID to be inconsistent with the terms and conditions of this MOU shall immediately be refunded to IFDC.

WWF will comply with the requirements of OMB Circular A-133. A copy of the A-133 audit, or a statement that there were no material findings, will be submitted to IFDC's Supervisor, Accounting Services, by WWF within thirty (30) days of completion of the audit. In cases of non-compliance with federal laws and regulation, WWF will provide copies of responses to the auditor's report and a plan for corrective action.

2.2.6 Refunds

(a) There will be no advances under this MOU.

(b) Funds not disbursed to WWF at the time the MOU expires or is terminated shall revert to IFDC, except for such funds encumbered by WWF by a legally binding transaction applicable to this MOU. Any funds advanced to but not expended by WWF at the time of expiration or termination of the MOU shall be refunded to IFDC except for such funds encumbered by WWF by a legally binding transaction applicable to this MOU.

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(c) If, at any time during the life of the MOU, or as a result of final audit, it is determined that funds provided under this MOU have been expended for purposes not in accordance with the terms of this MOU, WWF shall refund such amount to IFDC.

2.3 Language

The MOU has been executed in English, which shall be the binding and controlling language for interpretation of the terms and conditions of this MOU.

2.4 Subagreements

It is understood that WWF may carryout the work described under this MOU in collaboration with others. It is further understood that funds provided to WWF may be used to support work carried out by collaborating institutions. WWF shall ensure that the specific conditions of this MOU (i.e., Section 2.0, Specific Conditions) shall apply to all such subagreements.

2.5 Revision of MOU Budget

(a) The approved MOU budget is the financial expression of WWF's program.

(b) WWF shall immediately request approval from IFDC when there is reason to believe that within the next 30 calendar days a revision of the approved MOU budget will be necessary for any of the following reasons:

- To change the scope or the objectives of the program and/or revise the funding allocated among budget line items by more than ten percent of the total budget amount unless the schedule states otherwise.
- Additional funding is needed.
- WWF expects the amount of authorized funds to exceed its needs by more than $5,000 or five percent of the MOU budget, whichever is greater.

(c) Except as required by other provisions of this MOU specifically stated to be an exception from this provision, IFDC shall not be obligated to reimburse

WWF for costs incurred in excess of the total amount obligated under the MOU. WWF shall not be obligated to continue performance under the MOU (including actions under the "Termination Procedures" provision) or otherwise to incur costs in excess of the amount obligated under the MOU, unless and until IFDC has notified WWF in writing that such obligated amount has been increased and has specified the new MOU total amount.

2.6 Other Terms and Conditions

The following terms and conditions, which are applicable to the MOU by and between USAID and IFDC, shall be integral part of this Agreement.

2.6.1 Official Contacts

The contacts under this MOU for all official contacts are as follows:

IFDC Technical
Dr. Lawrence L. Hammond
Director, Research and Development Division
IFDC
PO Box 2040
Muscle Shoals, AL 35662, USA
Telephone: 256/381-6600, extension 270
FAX: 256/381-7408
lhammond@ifdc.org
www.ifdc.org

IFDC Business
Mr. John H. Allgood
Director, Finance, Administration, and Support Services
IFDC
PO Box 2040
Muscle Shoals, AL 35662, USA
Telephone: 256/381-6600, extension 211
FAX: 256/381-7408
jallgood@ifdc.org
www.ifdc.org

WWF Technical/Business
Kate Newman

Director, East and Southern Africa
World Wildlife Fund/US
1250 24th Street, NW
Washington, DC 20037 USA
Tel: 202-778-9524
Fax: 202-861-8377
kate.newman@wwfus.org

2.6.2 Publications and Media Releases

If it is WWF's intention to identify USAID's contribution to any publication, video or other information/media product resulting from this MOU, WWF shall state that the views expressed by the author(s) do not necessarily reflect those of USAID. Acknowledgements should identify the sponsoring USAID Office and Bureau or Mission as well as USAID substantially as follows:

"This [publication, video or other information/media project (specific)] was made possible through support provided by the Center for Economic Growth and Agricultural Development, Office of Agriculture and Food Security, under the terms of the MOU. The opinions expressed herein are those of the author(s) and do not necessarily reflect the views of USAID."

WWF shall provide the relevant strategic objective or results package team with one copy of all published works developed under this MOU and with lists of other written work produced under the MOU.

Except as otherwise provided in the terms and conditions of the MOU, the author or WWF is free to copyright any books, publications, or other copyrightable materials developed in the course of or under this MOU, but USAID reserves a royalty-free nonexclusive and irrevocable right to reproduce, publish, or otherwise use, and to authorize others to use the work for U.S. Government purposes.

2.6.3 Reports and Data

WWF shall send to the IFDC Technical Contact at the address included in this MOU, quarterly progress reports in a form and substance satisfactory to IFDC. The quarterly reports will provide a brief report on the status of activities being undertaken to implement this project during the previous 30 days. The quarterly reports shall indicate progress toward achieving Program objectives and implementing approved work plans. The reports shall include, but not be limited to, the following information:

- Status of achievement of program goals, objectives, and benchmarks specified in the annual work plan
- Progress or completion of components, elements, or activities against planned targets
- Program description
- Other accomplishments or program highlights
- Identification and explanation of significant problems which have been encountered
- Description of planned corrective action

The monthly and quarterly reports may be submitted in electronic format and are to be delivered to IFDC within 7 calendar days and 20 calendar days, respectively, of the end of the reporting period. A final report addressing the same components included in the quarterly report is to be submitted to IFDC by WWF within 45 calendar days of the ending date of this MOU. The reports submitted to WWF to IFDC and supporting materials compiled in performing the services shall be the property of USAID.

WWF is also required to submit copies of reports publications, produced within each activity as requested by IFDC (e.g., workshop proceedings, PowerPoint presentations, etc.).

2.6.4 Termination

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This agreement may be terminated, in whole or in part, by either party at any time upon 30 days written notice of termination. Upon receipt of and in accordance with a termination notice from the IFDC, the WWF shall take immediate action to cease all expenditures financed by this MOU and to cancel all unliquidated obligations if possible. Further, upon receipt of notice of termination, the WWF shall not enter into any further obligations under this MOU. Except as provided below, no further reimbursement shall be made after the effective date of termination. The WWF shall within 30 days of the effective date of termination repay to IFDC all unexpended funds that are not otherwise obligated by a legally binding transaction applicable to this MOU. Should the funds paid by IFDC to the WWF prior to the effective date of termination be insufficient to cover the WWF's obligations in a legally binding transaction, the WWF may submit to IFDC within 90 days after the effective date of termination a written claim for such amount. The IFDC shall determine the amount(s) to be paid by IFDC to the WWF under such claim in accordance with the "Allowable Costs" provision of this MOU.

2.6.5 Dispute Settlement

All reasonable efforts will be made to resolve any dispute which arises out of the performance of this MOU. However, should amicable resolution not be achieved within 30 days of written notification of the issue under dispute, Reconciliation of disputes which cannot be handled amicably will be settled based on the determination of the USAID Technical Representative.

2.6.6 Investment Promotions

No funds or other support provided hereunder may be used in a program or activity reasonably likely to involve the relocation or expansion outside of the United States of an enterprise located in the United States if non-US production in such relocation or expansion replaces some or all of the production of, and reduces the number of employees at, said enterprise in the United States.

No funds or other support provided hereunder may be used in a program or activity the purpose of which is the establishment or development in a foreign country of any export processing zone or designated area where the labor, environmental, tax, tariff, and safety laws of the country would not apply, without the prior written approval of IFDC.

No funds or other support provided hereunder may be used in an activity which contributes to the violation of internationally recognized rights of workers in the recipient country including those in any designated zone or area in that country. This provision must be included in all subagreements.

2.6.7 Non-Liability

IFDC does not assume liability for any third party claims for damages arising out of this MOU.

2.6.8 Notices

Any notice given by either party under this MOU shall be sufficient only if in writing and delivered in person or faxed to the official contact persons identified in 2.5.1

2.6.9 Special Provisions

WWF shall comply with USAID environmental regulations (22 CFR Section 216 "Regulation 16") with respect to the activities to be undertaken under this MOU.

2.6.10 Procurement Policies and Procedures

Because USAID is the sole contributor, USAID procurement policies and procedures are applicable (22 CFR Section 226 and ADS 308.5.7a).

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2.6.11 Ineligible Countries

Activities under this agreement may only be carried out in countries that are eligible to receive assistance under the Foreign Assistance Act. WWF shall provide IFDC in advance a list of those countries where activities are planned under this MOU.

2.6.12 Entire MOU

Unless otherwise specified, this MOU embodies the entire understanding between IFDC and WWF for the services to be provided and any prior to contemporaneous representations, either oral or written, are hereby superseded. No amendments or changes to this MOU, including, without limitation, changes in the statement of work, total estimated cost, and period of performance, shall be effective unless made in writing and signed by authorized representatives of the parties.

FOR AND ON BEHALF OF IFDC

By: John H. Allgood / by LH
Name: JOHN H. ALLGOOD
Title: DIR., FINANCE and ADMINISTRATION DEPT.
Date: MARCH 22, 2002

FOR AND ON BEHALF OF WWF

By: [signature]
Name: NANCY J. DUNN
Title: CHIEF FINANCIAL OFFICER
Date: 3/27/02

WITNESS:

By: Amber N Hammock
Name: Amber N. Hammock
Title: SR. SEC. / ASSC. PERS. OFF.
Date: MARCH 22, 2002

WITNESS:

By: [signature]
Name: [signature]
Title: Director, Contracts Services
Date: 3/27/02

Attachment 1

WWF GIS STRATEGIC SUPPORT AND ANALYSIS FOR SOUTHERN AFRICA

A Proposal to
The USAID Geospatial Information in Resource Management in Southern Africa Program

Submitted by WWF SARPO through WWF US

December 20, 2001

A TEN MONTH GRANT

29TH FEBRUARY TO 21ST DECEMBER, 2002

1. Background

Computer based geographical information systems (GIS) provide powerful techniques for capturing, storing, analyzing and displaying spatial information. GIS and Remote Sensing (RS) are becoming increasingly important tools in environmental management and research. Institutions across Africa are turning to GIS and RS to help solve the complex problems presented by the need to integrate ecosystem management objectives with evolving human dynamics. GIS and RS technologies allow spatial analysis to develop more appropriate and sophisticated approaches to conservation and development at scales ranging from the household to the ecoregion level.

In Southern Africa, WWF has been using GIS for more than a decade as a tool to support a range of conservation objectives in the region. In recent years, WWF has found that an increasing number of government, university and NGO partners are seeking assistance or collaboration to either develop their own internal GIS capacity or to work jointly to solve specific conservation challenges using GIS resources and databases.

At present, WWF's principal GIS capacity in Southern Africa is housed at WWF's Southern Africa Regional Program Office (SARPO) in Harare, Zimbabwe. The original GIS was developed in response to earlier WWF projects that required maps and analysis of settlement, land and resource patterns in the Zambezi valley. The WWF study of the likely impacts of climate change in the SADC region also stimulated a spatial examination of alternative strategies, such as wildlife-based production systems as a land-use in the face of increasing aridity in the region. More recently, services have been provided to studies on Trans-Boundary Conservation Areas (TBCAs) in Southern Africa and ecoregion conservation initiatives such as the Miombo Woodlands, Lake Malawi/Niassa/Nyasa and Eastern African Marine Ecoregion Programs, which cover from three to ten countries each. Thus, SARPO's GIS capacity was founded on projects where spatial data have been generated, collated, analyzed and used for conservation action at local, national and regional scales.

A number of key WWF partners and affiliates in other parts of the region are also making use of GIS/RS technologies as a tool in natural resource management. One of the best examples is the dedicated GIS that has been developed for the national Community-Based Natural Resource Management (CBNRM) Program in Namibia with support from WWF's USAID-funded Living in a Finite Environment (LIFE) Project.

While SARPO has developed relationships with some individuals and organizations involved with large-scale, regional GIS/RS initiatives, it is acknowledged that there is considerable potential value in increasing these levels of collaboration. We also seek to increase our dissemination of capacity-building support in the use GIS/RS technologies as tools in natural resource management across Southern Africa.

2. Project rationale

SARPO, and a number of its key collaborators, initiated a process during the past year of critically examining their capacity and ability to support activities aimed at enhancing GIS efforts among their partners and affiliates. There was a strong feeling that considerable value could be added to regional natural resource focussed GIS efforts by:

- maximizing the latent value of existing data sets by facilitating the creation of in-country and regional synergies based on sharing compatible directories, systems, training and approaches;
- exploring methods of learning of and accessing new and innovative information and data (including imagery), products, approaches; and
- creating awareness of natural resources information and the potential for solving environmental problems.

A first draft of a long-term goal for SARPO related to this topic was also developed:

Long-term Goal

As a broad goal, WWF SARPO strives to contribute to ecoregion conservation, including constituent ecological processes, systems and species, in southern and eastern Africa. This includes the extension of wildlife as a land use and the development and support of integrated conservation and development initiatives, such as CBNRM. Implicit in this broad goal is the application of GIS and Remote Sensing as analytical and predictive tools and the need to enhance natural resource management by making these technologies accessible to as wide a range of users as possible.

Immediate Objective

To create an awareness of the value of remotely sensed data and GIS technologies as natural resource management tools and initiate a program aimed at building capacity to allow WWF personnel and associates in southern and eastern Africa make effective use of the technologies. The guiding principle underpinning this objective is the need to create synergies and networks based on the incentives of shared skills and data, compatible directories and systems, and a common metadatabase and search engine.

A suggested long-term approach to supporting the regional GIS efforts was compiled and three levels of support were identified, with a number of activities underpinning each one. The following table represents activities in this longer-term strategy. The activities outlined for this proposal (discussed under heading 4) shall contribute to this broader, long-term approach.

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Envisaged levels of long-term support

LEVEL OF SUPPORT	AIMS	GOAL
1. Regional level	• Develop systems (standards, metadatabase, directory structures, customized user interfaces, etc.) that can be used by country user groups. • Provide training, particularly of locally based trainers. • Provide specialist technical support for complex problems. • Encourage sharing of data, systems and local expertise by providing incentives. • Acquire funds for providing incentive grants to country user groups.	Establish institutional infrastructure to ensure GIS sustainability in the region.
2. Country user group level (See Appendix 1 for more details.)	• Encourage establishment of local GIS user groups. • Encourage data/information sharing. • Encourage standardization. • Develop local user technical support group. • Enhance sustainability of GIS	Establish institutional infrastructure to ensure GIS sustainability in each country.
3. Problem-oriented GIS Projects	• Ensure these temporary projects leave data and information in a system and format that will be subsequently accessible and used by local users. • Promote use of existing data, thereby saving project resources (reducing data capture costs) and serving to improve quality of existing data.	Problem solving.

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3. Project Technical Partners and Network Participants

SARPO will collaborate with a number of US and regional technical partners to access data, technology and training in order to disseminate the same to WWF's staff and associate institutions across the region.

Technical partners include, but are not limited to:

- Environmental Systems Research Institute — ESRI (USA)
- National Imagery and Mapping Agency — NIMA (USA)
- National Atmospheric and Space Administration — NASA (USA)
- National Oceanic and Atmospheric Administration — NOAA (USA)
- National Research Council — NRC (USA)
- U.S. Agency for International Development — USAID (USA)
- U.S. Geological Survey — USGS (USA)
- University of Virginia, Miombo Network — UVA (USA)
- WWF/US Conservation Science Program — WWF/US CSP (USA)
- Scientific and Industrial Development Center — SIRDC (Zimbabwe)

WWF Program Offices and Associate Organizations in the GIS User Group Network will most likely include, but are not limited to:

- WWF/Tanzania Program Office, Dar es Salaam — WWF/TPO
- WWF/East Africa Program Office, Nairobi — WWF/EARPO
- WWF/Mozambique Country Office, Maputo — managed by WWF SARPO
- WWF/Zambia Country Office, Lusaka — managed by WWF SARPO
- WWF Living in a Finite Environment Project, Namibia — managed by WWF US
- WWF/South Africa, Stellenbosch — WWF/RSA
- Forestry Commission, Zimbabwe
- Department of National Parks and Wildlife, Zimbabwe
- University of Zimbabwe Tropical Resource Ecology Programme
- Veterinary Department, Ministry of Agriculture, Lands and Resettlement, Zimbabwe
- Ministry of Environment and Tourism, Namibia
- Namibia Nature Foundation, Namibia
- University of Namibia's Veterinary and Agriculture departments
- Zambia Wildlife Authority (ZAWA)
- Forestry Department, Zambia
- University of Zambia
- DNFFB (Wildlife Department), Mozambique
- Ministry of the Environment, Mozambique
- University of Eduardo Mondlane, Mozambique
- Tanzania National Parks (TANAPA)
- Wildlife Department, Tanzania
- East African Wildlife Society, Nairobi

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4. Project Activities

The following activities presented in this proposal have been identified from within the overall framework as critical for near-term implementation.

1. Activity: Develop a GIS directory structure for SARPO.
   Rationale: The use of a common and compatible directory structure is one of the incentives for participation in a GIS network. For example, the Namibian experience of using a standard structure is beginning to show the following benefits:
   - Streamlining standard GIS operations through sharing projects.
   - Easier technical support.
   - Greater efficiency of updating user-group's data sets.
   - Promotion of data sharing.

   The development of an appropriate directory structure in the Harare office can have relatively quick and tangible results given the range of activities being supported.
   Approach: Consultants shall provide technical support to SARPO to develop the structure. This may be modeled on existing systems and experience in the region. This structure shall also be disseminated to partners in the region to be used as a model for in-country initiatives. As part of this activity the directory structure shall be "field-tested" in a few collaborating institutions. "On-line" training support from ESRI shall be key for training SARPO staff and collaborators.

2. Activity: Develop metadatabase system and appropriate search engine.
   Rationale: There is little doubt that lack of easy access to environmental data is a major limiting factor for environmental planners, researchers, managers and decision-makers. This has also led to duplication of effort and placed strain on often limited financial and human resources. This activity shall not only make data more accessible to diverse users but will also encourage communication and cooperation across programs and countries.
   Approach: USGS shall be requested to assist with selecting and refining the most appropriate system. Training in that system shall also be requested. It is further hoped that the system may be made available, including training, to partner institutions that distribute environmental data. Such an approach would serve to increase the critical mass of participating institutions.

3. Activity: Develop examples of the value of remotely sensed and other geo-spatial data. Implicit in this activity is the use of spatial analysis.
   Rationale: There is a need to develop or "package" existing examples of the use and value of remotely sensed data and GIS technologies in natural resource management. These "packages" or "roll-out models" shall have value for not only potential regional partners but would also serve the needs of providing a showcase for the World Summit on Sustainable Development (WSSD), where partners in this program will be presenting the use of these technologies in Africa.

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Approach: Examples used should display a broad approach to the use of GIS RS and should include obvious elements of spatial analysis. If at all possible, one example should aim to show how these technologies could contribute to improved resource management at local levels. This would have real significance for many of the potential user-group participants. A "bigger picture" example could also be developed and showcase a national, trans-boundary or regional activity.

While the limited time may make it difficult to undertake new projects, there is every indication that there are a number of examples of existing projects that could be "packaged" to meet the needs of both the regional awareness campaign and the WSSD. If required, existing projects may be enhanced, where appropriate and or desirable, by additional spatial analysis. Examples include:

- Miombo Ecoregion Conservation planning activities.
- National Atlas Project in Namibia (to be completed by mid 2002).
- Game count in NW Namibia where 5,2 million hectares were covered in a single event. A large percentage of the area is either communal-land conservancies or emerging conservancies and the count was characterized by the participation of diverse groups who had access to and the benefits of satellite imagery and GIS technologies.
- The use of GIS as a tool in the Namibian CBNRM programme.
- A retrospective analysis land-cover change of the Niassa Selous corridor using RS imagery by the University of Virginia in conjunction with the Miombo Network – a collaboration of regional scientists working in the context of the Miombo woodlands. This would be a new analysis.

This list is not exhaustive. There are extremely good examples in the region, which will be investigated in the first phase of this program. SARPO shall consult with partners and decide upon the most suitable approach given time and budget limitations.

4. **Activity:** Undertake awareness creation visits to WWF offices and partner organizations in the region.
Rationale: Central to the entire SARPO initiative is the support of "user-groups" in the region (please see attached diagram).
Approach: The approach will be based on creating incentives for promoting long-term relationships and the adoption of GIS technologies, robust data collection and analysis. This activity will involve the presentation of "good practices" and incentives for developing synergies between users. It is envisaged that interested parties, such as SIRDC in Zimbabwe, could be invited to support this activity, and would visit at least two WWF partner offices, e.g. WWF Zambia and Mozambique Coordination Offices, the University of Eduardo Mondlane, and the Namibia Nature Foundation.

Where possible and appropriate, support resources from US-based collaborators (e.g. subsidized software, access to remotely sensed data, etc.) shall be offered to key partners.

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A cautious approach shall be required as the limited time and funds of this project shall not allow in-depth support. It is felt, however, that initial support of software and training shall contribute to a platform for the next logical phase of the project.

5. **Activity:** Explore and establish support in respect of software, satellite imagery, training and metadata systems from potential partners such as ESRI, USGS and others.
   Rationale: There is little doubt that there are considerable support resources, and willing partners, who have the potential to contribute to the value, viability and sustainability of GIS technologies in the region.
   Approach: SARPO shall coordinate the investigation of possible areas of support and cooperation from the potential USA-based institutions – e.g. USAID, ESRI and USGS. This activity would also involve establishing the procedures to allow participating individuals or organizations access to these resources. The developing network in the region could also be a focal point for key partners to be given exposure to various technologies – e.g. Winrock's radar and videography biomass monitoring.

6. **Activity:** Initiate GIS support (hardware, software and appropriate data) for one WWF regional office.
   Rationale: During this initial phase it is important to explore and implement the procedures required to support the establishment of a GIS facility in a WWF country office.
   Approach: A few regional practitioners shall provide the required technical support to establishing a GIS for one WWF Regional Support Office. Resources discussed under activity 5 shall also be used to support this effort. Furthermore, this activity would also see the initiation of a country user-group network. This activity would give a very good indication of what would be required for wider regional support for a future project.

7. **Activity:** Write longer-term GIS/natural resource management project proposal.
   Rationale: A critical mass of GIS/RS users in the region is required to achieve the vision of making these technologies an effective and widely adopted natural resource management tool. A number of regional partners have recognized this and indicated the need of a longer-term proposal to support not only GIS and related analyses, but also to promote the sharing of skills and "best practices" of natural resource management.
   Approach: This project shall provide good indications of what resources and approaches may be required in the longer term to achieve the long-term goal.
   Alternative funding shall be sought to compile a three to five year proposal.

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WORKPLAN

Activity	Lead Responsibility	Time frame
1. Develop GIS structure for SARPO office	SARPO	Feb - Dec
2. Develop meta-database system	USGS	Feb - Dec
3. Develop examples of remotely sensed data.	P Bartel. UVA	Feb - Aug
4. Regional "awareness"	SARPO	Feb - Dec
5. Explore support possibilities	SARPO	Feb - Aug
6. Pilot GIS support to one potential partner	SARPO	April - Dec
7. Long-term proposal development	SARPO	Sep - Dec

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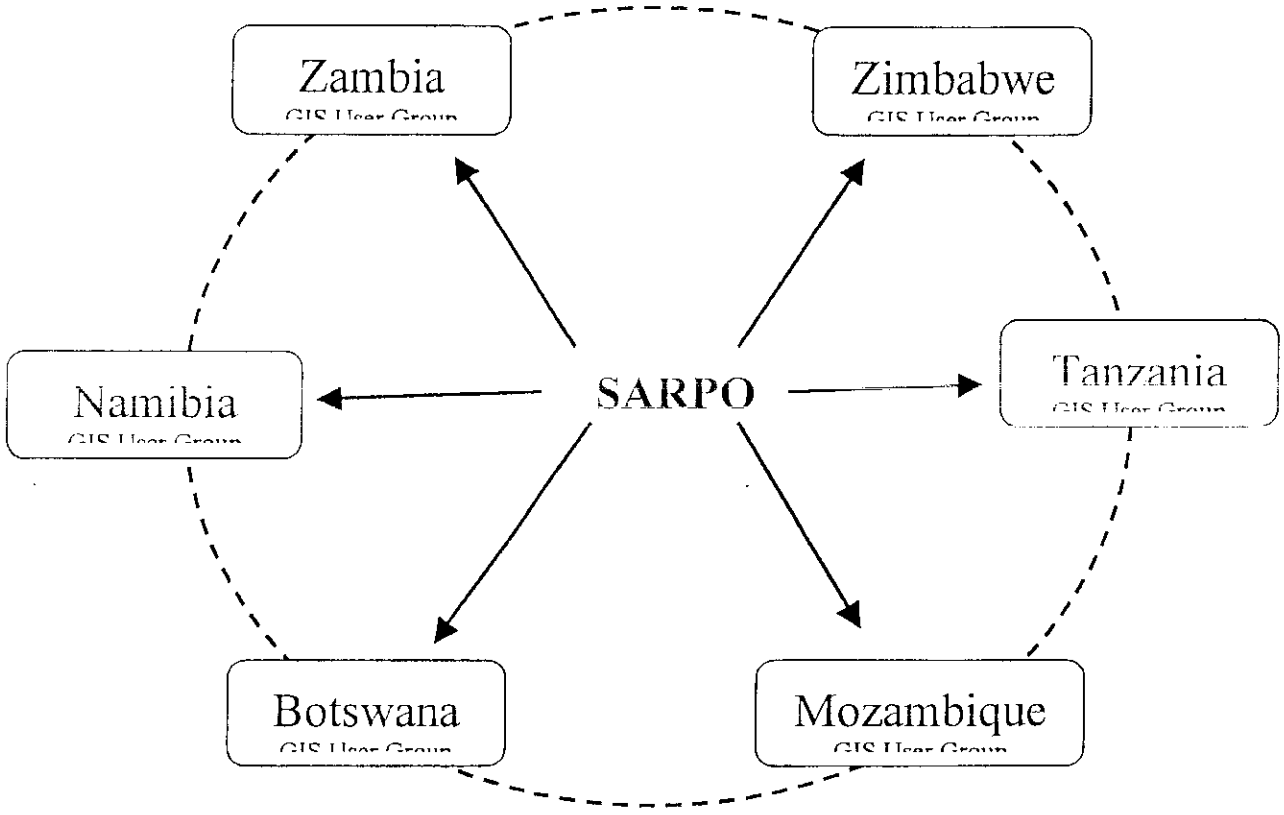
Proposed SARPO Support Strategy for GIS in the Region

SARPO Office:

- Provides grants to Country User Groups
- Provides roll-out systems for use by County User Groups
- Provides technical support to Country User Groups
- Provides/ facilitates training (managers, GIS technicians, GIS analysis)
- Provides incentives for data sharing
- Provides incentives for common standards, directory structures, metadatabase
- Acquires funds for supporting regional GIS cooperation & sustainability
- Promotes analytical use of GIS in projects

SYNERGY IN REGION IS BASED ON:

- *Compatible directories & systems*
- *Common Metadatabase (broader than just GIS)*
- *Common Search engine for finding and accessing data*
- *Data sharing*
- *Individual GIS projects go ahead but contribute to building the information base*



Country User Groups:

- Voluntary & independent association of GIS workers and institutions
- Work to promote common standards, directories, metadatabases and data sharing
- WWF country offices could provide secretariat services to Country User Groups

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IFDC INTERNATIONAL FERTILIZER DEVELOPMENT CENTER • MUSCLE SHOALS, ALABAMA 35662 USA
P.O. BOX 2040 • 256-381-6600
EMAIL-general@IFDC.org
TELEFAX NO. 256-381-7408

November 19, 2002

World Wildlife Fund, Inc.
c/o Lee A. Zahnow
Director for Contracts Services
1250 24th Street, NW
Washington, DC 20037

Dear Mr. Zahnow:

Amendment Number 1 to MOU between the International Fertilizer Development Center (IFDC) and World Wildlife Fund (WWF), Inc., in Washington, DC, to Support Activities Aimed at Enhancing GIS Efforts Among WWF SARPO Partners and Affiliates

This letter shall serve as Amendment Number 1 to the Memorandum of Understanding between IFDC and WWF to support the Geographic Information for Sustainable Development (GISD) project. The parties to the MOU agree that article **2.1 Effective Dates of the MOU** is hereby changed as follows:

2.1 Effective Dates of the MOU
The effective dates of this MOU are January 21, 2002-January 31, 2003.

All other terms and conditions of the MOU by and between IFDC and WWF shall remain in full force and effect. If you concur, please return one signed copy to IFDC for our records.

Sincerely yours,

John Allgood for A. H. Roy

Amit H. Roy
President and Chief Executive Officer

ACCEPTED AND AGREED TO:

World Wildlife Fund (WWF), Inc.

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Final WWF Project Technical Report

Project Number	01629/02
Sub-Project Title	GIS Strategic Support and Analysis for Southern Africa, WWF-SARPO (GISD)
Reporting Period	January – March 2003 & FINAL REPORT

1. Significant Change(s) to Objectives or Context during the Reporting Period

Although the original Grant Agreement was for the 10 month period 29 February-21 December 2002, the sub-agreement between WWF-US and WWF-International was only dated as of 24 April 2002, with the terms of the sub-agreement commencing 1 March and ending 31 August 2002. Funds for project implementation were finally received in the second half of May.
Nevertheless, it was possible to implement some components of the project during the first quarter of the reporting period, January-March 2002, with most project activities either taking place in the second quarter, April-June and thereafter. It was evident therefore, that an extension would be required beyond the initial completion date of 31 August, especially since important activities had still to be undertaken including the showcase presentation at the WSSD meeting in Johannesburg, South Africa, during August-September 2002, metadatabase training and regional awareness.
Accordingly an extension was applied for, and granted until March 2003. Most project activities were concluded by end December 2002. The exception was the installation of an electronic website/email server.

2. Progress towards Objectives

Development Goal: WWF SARPO contributing to ecoregion conservation in southern & eastern Africa, including the extension of wildlife as a land use and the development and support of integrated conservation and development initiatives.
Immediate Objective: Awareness, value and effective application of remotely sensed data and GIS technologies as conservation and natural resource management tools achieved through capacity building of WWF SARPO and regional partners with emphasis on:
The establishment of institutional infrastructure to ensure regional and in-country GIS sustainability
The development of GIS-based analytical and predictive approaches to problem solving
Project Activities:

A. Develop a GIS directory structure for SARPO
B. Develop a metadatabase system and appropriate search engine
C. Develop examples of remotely sensed and other geo-spatial data
D. Undertake awareness creation visits to WWF offices and partner organizations in the region
E. Establish support in respect of software, satellite imagery, training and metadata systems from

partners such as ESRI, USGS and USAID

F. Initiate GIS support (hardware, software and appropriate data) for one WWF regional office

G. Write longer-term GIS/Natural Resource Management Project proposal

Progress

A. Develop a GIS directory structure for SARPO

The use of a common and compatible directory structure is an important incentive for participation in a GIS network. As a precursor to such development and use, a review and assessment of the current status of facilities and capacity in the WWF SARPO GIS Unit in Harare was undertaken by a team of consultants working with SARPO GIS personnel during June and July 2002. This included assessments of hardware, software and a data inventory with recommendations for management, maintenance and institutional sustainability of the GIS Unit. The inventory has been written to CD and appropriately backed-up.

Other data sources have been used to populate the new directory structure as well as being backed up on CDs. Conversions of shape files from TNT Mips to ArcInfo and vice versa have been undertaken. This work has continued through the life of the project. The SARPO GIS Technician Mr. Wilson Munyaradzi was supported by the project until March 2003.

B. Develop a metadatabase system and appropriate search engine

Lack of access and duplication of effort can be avoided through making data more accessible through a common directory, databases and search engine as well as encouraging communication and cooperation across the region and between and within countries. At SARPO in Harare, a start has been made on the development of a directory structure together with data input and the maintenance and up-dating of the existing metadatabase, as outlined above. In this regard the Namibian experience, including that of the LIFE Project has been drawn upon extensively. The development of a search engine has still to be undertaken and will continue beyond the time frame of this initial project.

C. Develop examples of remotely sensed and other geo-spatial data

An existing Namibian example of the application of remotely sensed data was "packaged" as a showcase for the World Summit on Sustainable Development (WSSD), held in Johannesburg, South Africa during 26 August-4 September. Together with other examples of such data, this attractive and compelling showcase was well received by visitors to the Ubuntu Village exhibition. The approach of creating synergies between wide-ranging partners to promote the use of geospatial data provided a model presentation which was appreciated by a wide audience.

The presentation, "*GIS support to Community-Based Natural Resource Management in Namibia*", prepared by Namibian partners, demonstrates how the use of GIS and remote sensing technologies are allowing informed decisions to be made at community level. In turn these technologies are making a significant contribution to sustainable development, the empowerment of rural communities and promoting the sustainable management of natural resources. This presentation, constituted the Project's contribution to the WSSD showcase. It has been posted on an appropriate website and is available as a CD.

D. Undertake awareness creation visits to WWF offices and partner organizations in the region

Central to the longer term regional GIS strategy is the support of "user groups" in the region. This

activity was addressed at the annual SARPO Conservation Planning meeting when the proposed regional GIS strategy was outlined. Feedback to SARPO senior project personnel on the "clean up" and development of the directory structure was provided in Harare during July 2002 and an awareness visits was undertaken to Tanzania in September 2002 where visits were made to the WWF Tanzania Program Office and other institutions in Dar es Salaam. The intention is to create incentives for supporting the proposed strategy and promoting the adoption of GIS technologies, robust data collection and analysis. The work undertaken under activities A & B above provide the platform for this initiative.

E. Establish support in respect of software, satellite imagery, training and metadata systems

The coordination of initial support of software from Environmental Systems Research Institute (ESRI) through Geographical Information Management Systems (GIMS) has been undertaken and a range of appropriate ESRI software has been donated to the Project, and supplied to the Harare GIS Unit and to the Namibian Ministry of Environment & Tourism. The donation package comes with a one year maintenance charge. The following products, with maintenance costs met from the project budget, have been obtained through GIMS:

SARPO Harare

Item	**Units**	**Cost/Unit**	**Total cost (USD$)**
ArcView 3.3	5	400	2000
Spatial Analysis for 3.3	1	400	400
ArcView 8.3	2	600	1200
Spatial Analysis for 8.3	1	600	600
3D Analyst for 8.3	1	600	600
Total			**4800**

MET Namibia

ArcView 3.3	2
ArcView Extensions	2
ArcView 8.2	3
ArcView Extensions	2
ArcPad	4

Please note that MET are meeting the maintenance costs for the Namibian order.

Metadatabase training (also linked to Activity B, Development of metadatabase) was planned in conjunction with EROS Data Center, USGS. A week long training workshop was provided by USGS personnel during September 9-13 2002 at the Scientific & Industrial Research & Development Center's (SIRDC) Environment and Remote Sensing Institute (ERSI) in Harare. Participants numbered 14 and included personnel from the National Remote Sensing Directorate of Forestry and Directorate of Environmental Affairs both from MET, Namibia and the Forestry Commission, Surveyor General's Office, Center for Applied Social Sciences (CASS), ERSI-SIRDC and WWF SARPO in Zimbabwe.

F. Initiate GIS support (hardware, software and appropriate data) for one WWF regional office

This is linked to Activities A, B & E above and has addressed selected needs of the Harare GIS Unit and a number of requirements for MET in Namibia. The initial focus on supporting the Harare GIS Unit with its already well established facilities is linked to SARPO's role in developing a regional GIS strategy out of Harare, and acting as the central provider of a suite of services (roll out systems,

technical support, training, incentives for data sharing, fund provision etc) to user groups. Consequently, SARPO has to be properly equipped in terms of technical and human capacity to do so. A website and email server was purchased and installed with the balance of the remaining project funds. This facility will allow the storage, dissemination and exchange of image data and information within the regional program and with regional partners.

G. Prepare and write longer term GIS NRM project proposal

The Miombo Ecoregion Leader has undertaken this activity. Appropriate proposals have been developed and/or submitted, building on the progress that has been achieved during the life of this project and the longer-term proposal developed by SARPO in October 2001.

3. Achievements and Impact

Despite the delays in finalizing the funding of this project, considerable progress has since been made. Important achievements included the WSSD showcase, metadatabase training, networking with local, regional and international GIS practitioners and re-structuring the GIS facilities in Harare. All this should contribute to both the long term technical capacity and institutional sustainability of a regional GIS strategy.

Describe constraints which have affected progress (or refer to logframe) and measures taken to address them.

Whilst a delay in start up time has been a constraint to progress, a revised workplan was drawn up to cope with this and with the extension to March 2003, completion of this important first phase of the GIS strategy has been achieved.

4. Variances between budget and actual

The Financial Report has been submitted by SARPO Finance & Administration. The project budget was fully and effectively spent.

5. Targets and expected Developments for the next Reporting Period

Not applicable

6. Lessons learned and New Opportunities

- A balance has to be achieved between WWF SARPO's primary role in conservation and natural resource management activities and the degree to which it wishes to pursue and build its capacity in "state of the art" GIS/Remote Sensing technology
- Development of a regional GIS strategy and its component parts, such as the "balance" referred to above, and details such as choice of software, requires "buy-in" from both SARPO itself as well as its partners
- To achieve this "buy-in" requires "incentives" to do so, such as data access and sharing, within and amongst GIS user groups
- The process also requires a "champion" who can not only develop a regional vision for a GIS strategy but can also communicate it to SARPO and its partners

These lessons present both opportunities and challenges in the process of developing a regional GIS strategy.

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Project Monitoring Terms: Definitions

Performance

Indicators which illustrate the completion of incremental outputs and activities (usually at the project level) which, when taken together, should generate significant conservation achievements (i.e. our targets). This is the level of information normally covered in the Technical Progress Report. *Examples*:

- Number of educational and training materials published;
- Awareness raising and capacity building activities;
- Number of conservation specialists trained;

Note: Indicators of *performance* provide the information necessary to define the achievement of individual **outputs** and **activities** flowing from defined conservation targets. Within the context of a project annual workplan, successful completion of individual activities are often, in and of themselves, indicators of performance.

Responsibility: WWF projects and programs are fully responsible for tracking performance related indicators.

Timeframe: Short-term. Progress at the output/activity level should be measurable at a minimum on a six-monthly basis.

Scale: Medium to small scale. Performance indicators are most often tracked at the project level.

Achievement:

Indicators of significant accomplishments or successes which will reduce pressure on the environment of socio-economic origin or improve legislation and policy towards the protection of the environment in priority ecoregions and biomes. May also illustrate significant trends or changes towards a reduction of these pressures. *Examples*:

- Establishment of new protected areas;
- Sustainable management, or the development of management plans, for protected areas or important habitats/ecoregions;
- Signing and ratification of international conservation conventions.

Note: indicators of achievement are found within all priority areas of WWF, for example in our biome/eco-regional components as well as other regionally defined priority areas, such as environmental education, capacity building, etc. Normally, indicators of *achievement* define progress towards the objective outlining each conservation priority, and particularly the **targets** which flow from those objectives.

Responsibility: WWF is responsible for ensuring the necessary conditions for attaining conservation achievements. However, most achievements will require a close association with partner agencies and institutions.

Timeframe: Medium term. Once a target is established, it is not unreasonable to expect measurable change within 2 to 3 years.

Scale: Large scale, country-based. Given that the indicators described here are largely socio-economic and political in nature, they are most often manifested on a national basis.

Impact:

Indicators which show trends or significant changes in the "state" (quality, health) of priority habitats, ecoregions, biomes and species. *Examples*:

- Change in extent or quality of habitat over time
- Change in population and distribution of key indicator species over time

Note: indicators of impact, within the context of WWF's strategic planning framework, are found only in relation to priority biomes and ecoregions and are measured only in ecological or biological terms. Normally, indicators of *impact* describe progress towards the **mission, overall goal, vision** as well as the **global and regional priorities** of the program.

Responsibility: In most programs, WWF will not have the capacity necessary to comprehensively monitor conservation impact. Partnership arrangements will be necessary, and in many cases WWF may play a supporting rather than leadership role in the monitoring of impact.

Timeframe: Long term. A minimum of five years will likely be required to detect significant change in indicators of this type.

Scale: Very large scale. Given that the above defines "impact" in biological terms, it is suggested that the minimum scale at which to effectively measure impact and produce meaningful results is at the level of an ecoregion.

AFRICAN SPATIAL DATA INFRASTRUCTURE GUIDE OUTLINE

CHAPTER ONE: THE GUIDE APPROACH

Introduction
Background
Scope of the Guide
Contributors

CHAPTER TWO: GEOSPATIAL NEEDS ASSESSMENT (CONDITIONS AND CONSTRAINTS)[1]

Data Inventory
Providers and Users (stakeholders) Questionnaire
Resources Inventory
Existing Projects / Projects in the Pipeline
History (past projects)
Documenting data integration problems or duplication of effort (to demonstrate why SDI is needed)

CHAPTER THREE: SPATIAL DATA INFRASTRUCTURE EXPLAINED[2]

Geospatial Data Development - Building data for multiple uses
Metadata - Describing geospatial data
Geospatial Data Catalog – Making data discoverable
Geospatial Data Visualization - Online Mapping
Data Policies - Promoting public access to spatial information
Enabling Legislation
Leadership/partnership

CHAPTER FOUR: PARNERSHIP ARRANGEMENTS

Organizational structure (e.g., NAFGIM, NSIF, GEONAT, SISEI-Benin, EINMS-Zambia, etc.)
Achieving inter-institutional leadership
Meetings and workshops
Framework plans (e.g., Senegal Plan Geomatique, Botswana SDI Master Plan, etc.)
Connections with National Statistics Institutes (PARIS21)
Connections with Land Administration Programs
Connections with ICT programs and Ministries of Science and Technology
Connections with Utilities & Private Sector
Connections with universities

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1 This chapter will try to 'talk through' the thought and analysis process that colleagues undergo to assess the way forward. The chapter will point to the Appendix 'example forms' that could be used for inventories, questionnaires, etc.

2 This chapter should include diagrams, and on the Guide website, we should include a 'diagram library' that people could use for presentations and such.

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CHAPTER FIVE: A PHASED APPROACH / GETTING STARTED[3]

Geospatial Data Development - Building data for multiple uses

- GeoNat (Tunisia)
- Africover
- Global Map (Kenya)
- Core data standards (Uganda?, DEPHA?) [examples/guidelines for geo-identifiers]

Metadata - Describing geospatial data

Geospatial Data Catalog – Making data discoverable

- Enraemed (Ethiopia)
- NSIF (South Africa)
- RIIS (Horn of Africa)
- NAFGIM (Ghana)
- CSE (Senegal)

Geospatial Data Visualization - Online Mapping

- EIS-AFRICA/UNEP.net
- OGC GISD interoperability pilot project (EIS-AFRICA, RRSU, CSE, AGIS)

Data Policies - Promoting public access to spatial information

- NICI (various countries - UNECA)
- Enraemed (Data sharing protocol)
- Africover custodian guidelines
- NAFGIM draft policy
- Data pricing – Namibia Atlas (data free for download)

Enabling Legislation

- Spatial Information Bill (South Africa)
- Freedom of Information laws/constitution (various countries)
- The Access Initiative recommendations

CHAPTER SIX: FINANCIAL ASPECTS

Working with donors (Swedesurvey-Botswana, CIDA/NRCanada-GeoNat-Tunisia, UNITAR-SISEI-Benin, etc., Kenya-FAO-Africover)

Potential funding sources (FAO "country technical support", GEF policy, JICA, USAID, World Bank, etc.)

Garfield Giff funding models? (University of New Brunswick)

Cost recovery issues

International markets for value added products (e-commerce?) (foreign companies selling African data)

Public-private partnerships

Working with national budgets and treasuries (Benin, Tanzania)

CHAPTER SEVEN: GETTING HIGH LEVEL SUPPORT / COMMUNICATING SDI

Explaining relevancy, demonstrating impact, linking with the countries critical development issues (poverty reduction, governance, decentralization, trade, AIDS, etc.)

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3 Implementations and recommendations from African experts on building the components. This chapter depends on the level of detail provided by the experts. Keep in mind that there have not been that many implementations of components in Africa. It's possible that we could end up devoting a full chapter to metadata, but we might not have enough African-derived guidelines on data web mapping or data policy. We'll have to see how things unfold].

CHAPTER EIGHT: REACHING OUT TO THE REGIONAL AND GLOBAL SDI COMMUNITY

Permanent Committee for Spatial Data Infrastructure of the Americas
UNECA-CODI
GISD
EIS-AFRICA
GSDI
OGC
ISO TC211
FIG
ICA
Etc.
Sources for more information, for training capacity building

Authors

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   Database Manager: Environmental Information Systems Unit
   Ministry of Environment and Tourism
   NAMIBIA

GISD Project
Annex 13

GISD Project Travel

Name	Meeting	Date
Kate Lance	Pretoria, South Africa	November 17-27, 2002
Col. Mbareck Diop	Sioux Falls, South Dakota	October 20-26,2002
Mr. Amadou Mactar	Sioux Falls, South Dakota	October 20-26, 2002
Col. Mbareck Diop	Bamako, Mali	March 13-15, 2002
Mr. Bakary Djaby	Bamako, Mali	March 13-15, 2002
Kate Lance	Bamako, Mali	March 13-15, 2002
Issa Maman-Sani	Bamako, Mali	March 13-15, 2002
Robert Ford	Bamako, Mali	March 13-15, 2002
Andre Bassole	Bamako, Mali	March 13-15, 2002
Jean Abdias Compaore	Bamako, Mali	March 13-15, 2002
Petra Tschakert	Bamako, Mali	March 13-15, 2002
Patrice Sanou	Bamako, Mali	March 13-15, 2002
Yemane Tekleyohannes	Asmara, Eritrea	April 4-6, 2002
Douglas Nebert	Asmara, Eritrea	April 4-6, 2002
Jack Malone	Asmara, Eritrea	April 4-6, 2002
Amani Ngusaru	Asmara, Eritrea	April 4-6, 2002
Charles Dull	Asmara, Eritrea	April 4-6, 2002
Chukwudozie Ezigbalike	Asmara, Eritrea	April 4-6, 2002
Kate Lance	Asmara, Eritrea	April 4-6, 2002
Vedast Makota	Asmara, Eritrea	April 4-6, 2002
David Siriri	Asmara, Eritrea	April 4-6, 2002
Benson Wafula	Asmara, Eritrea	April 4-6, 2002
Robert Zomer	Asmara, Eritrea	April 4-6, 2002
Laban MacOpiyo	Asmara, Eritrea	April 4-6, 2002
Giovanni Narcisco	Nairobi, Kenya	April 7-16, 2002
Robert Ford	Nairobi, Kenya	April 7-16, 2002
Chandra Prasad Giri	Nairobi, Kenya	April 7-16, 2002
Paul V. Desanker	Nairobi, Kenya	April 7-16, 2002
Elifuraha G. Mtalo	Nairobi, Kenya	April 7-16, 2002
Jo Tagg	Nairobi, Kenya	April 7-16, 2002
Wilber K. Ottichilo	London, England	June 8-15, 2002
Tinashe Mandaza	London, England	June 8-15, 2002
Gerard M. Mtalo	London, England	June 8-15, 2002
Jocelyn T. Fenard	London, England	June 8-15, 2002
Souleymane Diop	London, England	June 8-15, 2002
Mbareck Diop	Johannesburg, South Africa	August 30-September 7, 2002
Aissata F. Bagnan	Johannesburg, South Africa	August 30-September 5, 2002
Mathieu Ouedraogo	Johannesburg, South Africa	August 30-September 7, 2002
David Siriri	Johannesburg, South Africa	September 1-5, 2002
Vedast Makota	Johannesburg, South Africa	September 1-5, 2002
Andre Bassole	Johannesburg, South Africa	August 23-September 7, 2002
Petra Tschakert	Johannesburg, South Africa	August 28-September 2, 2002

Name	Meeting	Date
Seif Madofe	Johannesburg, South Africa	August 28-September 1, 2002
Patrice Sanou	Johannesburg, South Africa	August 27-September 2, 2002
Labon MacOpiyo	Johannesburg, South Africa	August 22-29, 2002
Kolethi Gambo	Johannesburg, South Africa	August 25-28, 2002
Maman Issa	Johannesburg, South Africa	August 24-29, 2002
Yaser Bishr	Johannesburg, South Africa	August 28-September 5, 2002
Chris Reij	Johannesburg, South Africa	August 25-28, 2002
Joe Tagg	Johannesburg, South Africa	August 28-31, 2002
Giovanni Narciso	Johannesburg, South Africa	August 28-September 1, 2002
Kwabena Asante	Johannesburg, South Africa	September 1-4, 2002
Michelle Anthony	Washington, D.C.	January 25-29, 2003
Jeremiah M. Daffa	Denver, Colorado	February 10-19, 2003
Patrice Sanou	Denver, Colorado & Washington, D.C.	February 11-20, 2003
Jonathan G. Tagg	Denver, Colorado & Washington, D.C.	February 11-21, 2003
Elizabeth Gavin	Denver, Colorado	February 13-20, 2003
Laban MacOpiyo	Denver, Colorado	February 13-17,2003
Robert Ford	Denver, Colorado	February 13-14, 2003