Planning an Environmental Information Program for Rwanda

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Executive Summary

At the request of the Government of Rwanda and USAID, Dan Tunstall and Jake Brunner, consultants from the World Resources Institute (WRI) were asked to assist the Ministry of Environment and Tourism (MINETO):

o   to develop an inventory of environmental information;

o   to identify a set of indicators that could be used to assess changes in the state of the environment;

o   to prepare plans for strengthening environmental information in Rwanda, including suggested changes in the legal mandate; and,

o   to propose actions that the Ministry, USAID, other donors, and WRI should take in bringing about these changes.

The consultants worked closely with Jean Daniel NKUNDINEZA and Robert Winterbottom and coordinated their activities closely with Ernest RUKANGIRA. Beginning in 1985, and as a result of a more intensive effort launched in 1988, the Government of Rwanda has gone through the process of developing a national environmental strategy and action plan (SNER/PAE). They have made the improvement and use of environmental information a central component of their plans.

From May 1 to May 15 the consultants conducted interviews with more than 20 experts in the government and in research institutions in Kigali and Ruhengeri. The results of these interviews is summarized in the Inventory of Environmental Information Data Sheets included in this report as Annex 4. The Inventory is a draft and additional ministries and experts will need to be contacted. All the materials compiled from the interviews are available in the Ministry.

Findings and Conclusions:

1.   Various agencies of the government of Rwanda have over the past few years compiled a considerable amount of natural resource and environmental data. Extensive resource inventories are being completed or will be completed in the next few years. These include: mineral resources, water resources (springs), marais (wetlands), soils, peat, forests, the 1991 census of population and housing, and an intensive review and analysis of socio-conomic and development statistics at the level of the commune. In addition, the Division of Agricultural Statistics (DSA) has

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conducted a detailed survey of rural households for 10 years, which is generating valuable data about soil degradation, agricultural production, land tenure, prices, and food sufficiency. And there are ongoing data collection and research programs in geology, meteorology, cartography, fisheries, energy, industry, health, education, and economics and finance.

2.   Much of the information collected by the government is not available to other ministries and researchers (too few copies of reports are printed, and often government officials hold tightly to the remaining copies). Because there is little coordination, map scales and data collection methods are often not comparable across the country and between various administrative jurisdictions. The Inventory initiated by the consultants and Ministry staff was the first such effort undertaken and many officials were at first surprised by such requests for this information but welcomed the opportunity to share information and in many cases requested help in collecting environmental data.

3.   With the exception of the DSA database on agricultural production, the national censuses, and limited hydrological and meteorological data, there is a definite lack of time series data, which makes it difficult to prepare indicators of environmental change. Most data collection is undertaken as base line studies that are then used to help plan development projects. There is little interest in continuing these data efforts (by the government and by the donors) to track changes in the environment and to better understand how development activities influence (degrade, sustain, or improve) the resource base. A review of existing indicators revealed that there is virtually no data on changes in the productivity or condition of natural resources, and trends in environmental quality or other environmental changes.

4.   Many ministries lack well-trained staff and have limited budgetary support for information collection, analysis, and dissemination, except in the case of discrete, donor-assisted projects.

Recommendations:

1.   The consultants strongly recommend that the Government of Rwanda establish a National Environmental Information Center (NEIC) within the new Ministry of the Environment and Tourism. The NEIC would have four principal functions:

> o   to routinely compile all important documents and reports dealing with the environment in Rwanda and to catalogue, store, and make this material accessible to Ministry staff and later to the public;

o   to promote more systematic and comprehensive collectin
     of environmentally-related data, in a collaborative
     fashion, relying extensively on other ministries to
     actually carry out the surveys, sampling, and initial
     processing of information; the NEIC should consider
     compiling a database on all major development projects
     that may have an impact on the environment;

o   to analyze the data to reveal trends, linkages between
     socio-economic and biophysical conditions, to assess
     progress and achievement, and deepen understanding of
     environmental degradation and opportunities for
     sustainable use of resources. (If research and
     modelling projects are required, they should be
     undertaken in cooperation with local universities);

o   to report information to policy makers and the public
     by preparing periodic reports on the state of the
     environment, completing and widely distributing the
     inventory of environmental information, and other
     reports and material that raise public awareness.

2.   Three options for establishing the NEIC were developed
during the course of the mission. Option 3, or a relatively high
level of effort is recommended by the consultants. This would
require a staff of nine, with expertise in data analysis and
databases, natural resources, documentation, report writing, and
report production. Donor support of approximately $620,000 over
a 3-year period would be required for technical assistance,
training, computer hardware and software, travel, and funds for
an independent advisory committee. Up to $75,000 of the budget
is targeted for environmental data collection and monitoring by
the NEIC and other ministries and universities. It is assumed
that the Ministry would pay for local salaries, and most costs
related to local travel, rent, utilities, and other operating
expenses.

3.   The WRI consultants recommend that USAID continue to play a
lead role in the support of environmental information activities
in Rwanda. USAID has supported the establishment of the Division
of Agricultural Statistics, has supported processing the
decennial census, and the compilation of valuable data in the
fields of health and biological diversity. In addition to
financial support, USAID can encourage other donors to
participate, can encourage the government to pass national
environmental legislation that includes mandates for preparing a
state of the environment report and the development and use of
indicators, and requires all ministries to cooperate with MINETO
in the implementation of environmental policies and data
collection. Other donors are providing financial support for
natural resource inventories in Rwanda and should be asked to
join in supporting the establishment and operation of the NEIC.

4.   In addition to its environmental information activities, WRI is participating in a number of projects in Rwanda and the Institute welcomes opportunities for collaborating with the government, NGOs, and other organizations. WRI would welcome an opportunity to continue an advisory role with the NEIC and to work with NEIC staff and other government staff to develop a program to track indicators in the area of water quality, soil fertility, biological diversity, etc..

1.   Background and Purpose

Rwanda is a relatively small (24,670 square kilometers) landlocked country in central Africa and its remaining forests are the source of both the Nile and the Zaire rivers to the north and west. Of the 7.3 million people, more than 90% live off the land or participate in small-scale rural industry. Population density is the highest in Africa, and its annual population growth rate is 3.1%, second only to Uganda. Per capita income, as estimated by the World Bank, was approximately U.S.$310 in 1989. Economic growth in per capita terms averaged about 2.2% per year in the 1980s, substantially lower than in the 1970s when prices for agricultural exports were higher and more land was available for farming. Because so many people depend on agriculture for their livelihood, the quality and quantity of the natural resource base is considered essential for economic growth and social development.

In recent years this resource base has been severely weakened. Until the early 1980s the extension of cultivated land into pasture, forest and fallow, and onto steeper slopes (50% of farm land is steeper than 10%), exceeded the rate of population growth, thereby maintaining per capita food production. However, this extension into marginal land, and the subdivision ("morcellement") of family holdings (56% are smaller than 1 ha) reduced the supply of forage and forced livestock to ever more distant pastures. This, in turn, reduced the supply of manure which farmers depend on to maintain soil fertility. The resultant sharp decline in crop productivity and the reduced provision of meat and milk led to a per capita reduction in food production of 25% between 1986-89. The only solution for most farmers has been to extend cultivation into even more marginal and steeper land, which has intensified the processes of soil erosion and decline in soil fertility. Rwanda is therefore trapped in a vicious circle of declining per capita food supply and environmental degradation.

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During the past few years Rwandans have participated in an intensive review of their natural resources and environment quality in relation to development. In 1985, the first National Seminar on the Environment was held in Rwanda. This was followed by preparations for the National Environmental Action Planning process, including a detailed assessment of the conditions and trends of the environment in 1988 and in late 1989 by the completing of proposals for a national environmental strategy (SNER/PAE). See Volume I: Diagnostique and Volume II: La Strategie, August 1989, Ministere du Plan, Rwanda. During the past two years efforts to approve and implement the SNER/PAE were strengthened by the organization of the Environment and Development (PED) project in the Ministry of Planning. In late 1991 this activity became the Service National de l'Environnement (SNE) and was transferred to the Ministry of Agriculture, Livestock, and the Environment (MINAGRI). Just in the past few weeks, with the formation of a new government, the Ministry of Environment and Tourism (MINETO) was formed giving greater attention to environmental and natural resource concerns.

Throughout this period, the government has been involved in drafting an Action Plan that will be presented to donors for funding. The Action Plan consists of both environmental projects and sectoral projects that have a strong environmental component. With the establishment of the new Ministry of Environment and Tourism it is expected that the full plan of 20 projects will soon be presented to donors for consideration. One of the projects is directly related to the development of better environmental information. Others have a considerable information component.

Furthermore, the 1992 Work Plan and budget for the SNE contains substantial support for improving environmental information. It calls for:

o   preliminary studies to establish an environmental information system for Rwanda and the creation of a database to track environmental conditions and trends;

o   consultations and data collection in support of the preparation of a Rwandan state of the environment report;

o   implementation of a monitoring system and registry of potentially toxic substances;

o   establishment of a documentation center and referral service for the public; and,

o   provision of information needed to support environmental impact studies, planning, project evaluation, modelling, and other activities being developed by the SNE.

Clearly, the government of Rwanda intends for environmental information, analysis, and public reporting to play a central role in the development and implementation of its environmental policies and programs.

Responding to the new and broad interest in the environment by the Rwandans, USAID initiated its Natural Resource Management Project (NRMP) for Rwanda in 1989-90. At the request of the government, the NRMP has provided a senior environmental advisor, Mr. Robert WINTERBOTTOM, to the SNE. At his suggestion and with the support of the Director of the SNE, Mr. Ernest RUKANGIRA, the World Resources Institute (WRI) was asked to participate in a mission to Rwanda to assist in developing plans for an environmental information program. A previous mission in January by WRI staff David Gow, had helped to outline the need for such a mission.

The basic tasks of the mission were:

1. Assist staff in inventorying and evaluating environmental information and identifying major uses and users;

2. Assist staff in identifying appropriate indicators of environmental conditions and trends, and indicators that could be used to assess progress in achieving the goals of the national environmental strategy and action plan;

3. Assist in outlining needs for environmental information systems; monitoring programs including remote sensing; spatial analysis of resources and human pressures including development of GIS capabilities; and needs for reporting information to policy makers and public.

4. Discuss and suggest means for strengthening institutional arrangements required to support an environmental information program in the Ministry of the Environment and Tourism; and

5. Discuss ways in which environmental legislation could be strengthened by including a section dealing with the preparation of a state of the environment report and the development of a set of environmental and natural resource indicators.

6. Assist in preparing for a multi-donor mission, organized for late May by preparing preliminary plans and cost estimates required to establish an EIP in Rwanda.

A summary of the Objectives and Tasks of the consultancy is contained in the Annex along with a Calendar of activities.

2. Organization of the Mission

The major portion of the work of the consultants consisted of a series of detailed interviews with government experts in information dealing with environmental, natural resource, demographic, and development information. Interviews were conducted with the following ministries and other organizations, both public and private:

o   MINETO: Environmental quality.
o   MINAGRI: Agriculture and household statistics, forest inventories, national soil conservation strategy, marais (wetlands) inventory
o   MINITRAPE: Energy, water resources, cartographic service.
o   Carte Pedologique Rwanda: Soils mapping, soils suitability.
o   MINIMART: Geological research.
o   MINIPLAN: Census and development planning.
o   University of Rwanda at Ruhengeri: Geography department and cartographic laboratory.
o   Michigan State University (MSU) staff: GIS, socio-economic data.
o   Digit Fund/Karisoke Research Center: gorilla and habitat research, habitat mapping.
o   MINITRANSCO: Meteorological service.

The results of these interviews were summarized in data sheets, which when taken as a whole make up an Inventory of Environmental Information for Rwanda. (See Annex 4.)

In most cases, ministries were able to provide us with some documentation on their data collection activities, maps, reports containing data, or plans for publication. All these materials are being stored in MINETO.

The consultants were joined by Jean Daniel NKUNDINEZA, Chief of the Planning and Environmental Studies Division of the SNE and Robert WINTERBOTTOM, USAID-funded Environmental Advisor to MINETO.

During the period of the consultancy, MINETO was established combining the National Environmental Service and the Office of National Parks and Tourism (ORTPN). This event provided an opportunity for the consultants to suggest ways in which environmental information activities could be advanced in the organization of the new Ministry. At the same time, however, there was not enough time to fully gain the perspective and experience of the NES staff in understanding their needs for environmental information and their expectations in how such information would be used. Although the consultants interviewed more than 20 experts, we were not able to complete interviews

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with a number of important government agencies, notably ORTPN, ISAR and IRST, who are involved with environmental research and planning. We were also unable to meet with research staff in agriculture, NGOs, and private industry.

We view the Inventory as a beginning. Our expectation is that the NES staff will continue the interviews and expand the documentation. This information should provide the basis for many of the projects proposed for the National Environmental Information (NEIC).

3. Results of the Mission

Task 1.   Review of Existing Information and Major Users.

The information gathered about available maps and data bases is summarized in Tables 1 and 2. Eleven major mapping and data programs were contacted, interviews conducted, and materials collected. Basic information on each program is highlighted below:

Rivers and Lakes

The Direction Générale de l'Eau publishes the following data bases in the Annuaire Hydrologique:

o   A daily time series of minimum and maximum discharge (m^3/s) for 14 "stations de mesure de débits".

o   A daily time series of minimum and maximum water level (m) for 20 "stations de mesure de niveaux".

Water Quality

Over half the rural population depend on the 22,300 springs emanating from the highly fractured bed rock. Because of the rapidly rising population and possible water contamination, water quality testing is a priority task for the Direction Hydrologique et Gestion des Ressources en Eau. The principal data bases that exist or are in the process of being compiled include:

o   A UNICEF financed spring inventory started in 1988. Information on pH, conductivity, taste, discharge, number of people who depend on the spring, and location has been collected for 9 of the 10 préféctures. 1:50,000 maps showing the location and code for each spring are available. The data base will be complete by 1993.

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Table 1. Maps, Aerial Photos and Satellite Images for Rwanda

Subject:	Scale/Coverage/Year of Issue:		
Topographic maps	1:250,000 National 1985	1:50,000 National 1985	
Geological maps	1:250,000 National 1982	1:100,000 National 1982	
Soil maps	1:250,000 National 1992	1:50,000 National 1992	
Land use maps	1:100,000 National 1989	1:20,000 National 1987	
Forest maps	1:20,000 Nyungwe 1992		
Marais maps	1:50,000 National 1992		
Springs map	1:50,000 National 1993		
Aerial photos	1:50,000 National 1989-90	1:20,000 Nyungwe 1989-90	1:10,000 Major towns 1989-90
	1:5,000 Kigali 1989-90	1:50,000 National 1977-82	1:25,000 National 1977-82
Satellite images	SPOT National 1987-88	Landsat National 1986	

Source: Draft Inventory of Environmental Information, May 1992.

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Table 2.   **Databases for Rwanda**

Type:	Date:	Variables:
Census	1991	Age, employment, etc.
Commune	1991–present	Electricity, transport, education, etc.
Marais	1991–92	Vegetation, soil, etc.
Meteorological	1930–present	Rainfall, temperature, evaporation, etc.
Rivers, lakes	1950–present	Discharge, height, etc.
Springs	1992–present	pH, conductivity, discharge, etc.
Soils	1984–88	Composition, crop suitability, etc.
Land use	1989	Crops, forest, etc.
Agriculture	1984–present	Crop productivity, fallow, pasture, etc.

Source: Draft Inventory of Environmental Information, May 1992.

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o   The Direction Hydrologique et Gestion des Ressources en
        Eau is responsible for measuring water quality and
        setting minimum standards for drinking water. It is the
        intention of the Direction to test water quality on a
        continuous basis. A recently built GTZ financed water
        testing laboratory will facilitate this program.

Meteorology

The Direction Météorologique publishes the following
information:

o   A time series of daily rainfall for 150 "postes
        pluviometriques". The oldest "postes" date from the
        1930's.

o   A time series of daily rainfall and temperature for 24
        "stations thermo-pluviometriques".

o   A time series of daily temperature (min, max, soil),
        insolation, humidity, rainfall, potential
        evapotranspiration, etc. for 15 "stations synoptiques".
        These data are combined with information gathered from
        50 communes to provide advice on cropping practices and
        the application of fertilizer and pesticide. These
        recommendations, together with summary meteorological
        data from the 15 "stations synoptiques", are published
        every 10 days in the Bulletin Agrometeorologique at
        Phytosantaire.

o   Summary information for all three meteorologic time
        series is published annually in the Bulletin
        Climatologique.

Although not strictly speaking a data collection program,
the Strategie National de la Conservation des Sols (SNCS) has
published a number of special reports on soil erosion and
conservation. For example, based on detailed storm profiles
acquired from six "postes pluviometriques", it was shown that
rainfall across Rwanda is generally less erosive than expected
(average Universal Soil Loss Equation R-factor of 250); rapid
soil erosion is rather the result of poor agricultural practices.

Marais

The marais (wetlands) cover all lowlands that are wet part
or all of the year. Development of the marais is widely seen as
an opportunity to significantly increase agricultural production
and non-agricultural income from fish farming, brick making, etc.
The "inventaire de marais" has mapped and compiled three
databases on the marais which are stored as dBase files. The
databases include: the classification of marais into "naturel"

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(untouched), "emblavé" (some planting and harvesting of crops), "utilizé" (some regular method of drainage is implemented, but only enough to control the worst of flooding) and "aménagé" (drained and intensively cultivated), and data on crops, natural vegetation, soil, fishing activity, gravel and mining.

- o   The first database was compiled for the 333 first-order catchment areas occupied by marais.

- o   The second was compiled for the 2800 second-order catchments ("trançons") which make up the first-order catchments.

- o   The third database was compiled for the marais lying within the valleys of the major rivers the Nyabarango and Akanyaru.

- o   In addition to these databases, the project intends, if funds permit, to digitize the marais maps to assist the development of a master plan for development of the marais.

Soils

The Carte Pédologique du Rwanda (CPR) can provide the following data bases:

- o   The description of some 10,000 soil samples stored as an SPSS file.

- o   A soil data base with full descriptions of the 276 soil series present in Rwanda.

- o   The CPR has digitized 8 of the 43 1:50,000 soil maps of Rwanda using Arc/Info. It expects to have digitized the remaining maps by 1993. The digitized maps are available on a diskette.

- o   The CPR is also digitizing the 1:50,000 topographic maps for inclusion within Arc/Info as a digital elevation model (DEM) which may assist with agricultural suitability mapping. The DEM, however, may serve many other purposes. For example, GRID-Nairobi used a 25 km resolution DEM to improve the interpolation of temperature records from individual stations across the whole of sub-Saharan Africa for the purposes of disease mapping and prediction. A high resolution DEM of Rwanda could be used, for example, to parameterize the slope factors for the Universal Soil Loss Equation. So far, however, only one topographic map has been digitized.

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The SNCS (see Meteorology above) has published a number of special studies on soil erosion and conservation strategies. Of particular significance to MINETO may be the on-going study of the effectiveness of cooperative measures undertaken between NGOs and farmers to install and maintain anti-erosion devices and farming practices. In the past such measures proved largely ineffective because they had to be enforced by the extension workers themselves, often with littel regard to the economic realities of rural life.

Land Use

The 1989 Etude par Photo-Interpretation de l'Occupation des Sols et de la Disponibilite des Terres provides tables showing land use in 1987 (based on 1:25,000 black and white aerial photos), in 1989 (based on 1:100,000 SPOT multi-spectral positives) and the 1987-89 changes for each préfecture. Although comprehensive in terms of the number of cover types mapped, the maps and derived statistics on land use are not considered to be accurate at a scale of 1:20,000.

Agricultural Household Statistics

Since 1984, the Division des Statistiques Agricoles (DSA) has compiled a time series, up-dated weekly, on the agricultural activities, and household income and expenditure, for 1248 households from 70 of the 145 communes that make up the 11 prefectures. Each household can be identified by commune (although the results are only statistically significant at the préfecture level) and by the 14 agro-ecological zone. This survey holds a phenomenal amount of information; the task now is one of drawing meaning from the database, in order, say, to devise original and context-specific indicators of rural development.

In addition to this longitudinal survey, the DSA has also done a number of special surveys (e.g., non-farm employment and migration 1988, and agoforestry 1991). All data are stored as SPSS files. The principal data bases include:

o   The longitudinal survey asks questions on: production of the 8 crops which provide over 90% of the calorific intake, productivity of these crops (kg/ha), changes in crop production by month, number and size of holdings ("champs"), proportion of fallow, pasture and wood, livestock, etc.

o   The 1991 agroforestry survey questioned the 1248 households on: slope, anti-erosion measures (ditches, terracing, etc.), distance to work, use of manure or fertilizer, perceived environmental problems (soil erosion, insufficient fallow, etc.), source of fire wood, source of forage, etc.

Census Data

National censuses have been taken in 1948, 1970, 1978 and 1991. Three types of information based on the 1991 census are available from the Service National de Recensement:

o   The raw results from the 1991 census will not be available until March 1993, with the final results not due until June 1994. However, the provisional results from the 8,000 sample pre-census pilot study have been published as the Recensement Général de la Population et de l'Habitat au 15 Août 1991: Resultats Provisoires.

o   This study was used to refine the division of the country into 6213 enumeration districts ("districts de recensement"), each containing an average of 250 households, or 1,100 people. 1:25,000 maps for each commune, showing the division of the commune into secteurs and districts, are also available.

o   Results from the post-enumeration survey of 60,000 households are expected to be available later in 1992.

Socio-Economic Data at the Commune Level

In theory each commune publishes an annual monograph detailing the state of the environment, agriculture, economic growth, etc. for each commune. In practice, however, these are not published annually and are generally of uncertain reliability. To provide more accurate information the Direction Générale des Statistiques Socialles has, since 1991, has an employee in each préfecture in charge of collecting data for each commune. 100-200 variables are now sent to the Projet Assistance à la Planification for analysis. These variables include: population, health and hygiene, education, employment, habitat, radio, electricity, agriculture, livestock, agroforestry, commerce, transport and communication. Factor analysis of 48 key variables shows that the supply of electricity and telephone communication are the two main determinants of the level of development. This database is stored as Lotus and dBase files but is not yet available, primarily because of the extensive data processing that needs to be performed due to the different standards of data collection used in each commune.

Aerial Photos

Rwanda is richly endowed with black and white aerial photo coverage. The principal sets are:

o   National coverage at 1:50,000 is available for 1955-61, 1974, 1977-82 and 1989-90. The 1977-82 national coverage is also available at 1:25,000. Interpretation of the 1989-90 photos is being done by the Direction Générale de Forêt as part of its inventory of the Nyungwe forest.

o   Coverage of the four "forêts naturelles" is available at 1:25,000 for 1977-82 and 1:20,000 for 1989-90. The 1989-90 coverage is being used by the Direction Générale Forêt for a multi-donor funded inventory of the Nyungwe forest.

o   Coverage of the towns and surrounding areas of Kigali, Ruhengeri, Butare and Gitarama is available to 1:50,000 for 1989-90.

o   A set of 1980 1:25,000 false-color infrared prints of Ruhengeri and the Parc des Volcans is held at the Laboratoire de Cartographie, UNR, Ruhengeri.

Satellite Images

Two sets of satellite images of Rwanda are known to exist:

o   Four seven-band Landsat TM images covering the whole country, and all captured in 1986 (the precise dates of capture were unavailable), are stored on a 600 MB optical disk at the Division de Recherche Géologique et Mines. They are currently being used to improve geological maps at 1:100,000.

o   The 1989 Carte d'Occupation des Sols was based on photo-interpretation of 18 SPOT false-color infrared positives, corrected to level 1B (geometrically corrected to within 1.5 km), acquired at 1:400,000 and blown up to 1:100,000. The whereabouts of these positives is unknown.

o   There may be other images (both digital and prints) held at GRID or elsewhere abroad. However, the chance of acquiring cloud free SPOT or Landsat images on a regular basis in remote (as an indication of the problem of cloud cover, no nadir- or off-nadir looking cloud free SPOT images of the Parc National de Volcans have been obtained since first requested in 1990). This uncertainty, together with the poor spatial resolution

relative to the highly heterogeneous land cover), and
the high cost of purchase and the necessary hardware,
software and training, make the use of remotely sensed
data both expensive and of uncertain value, especially
for agricultural applications.

Conclusions:

Our inventory shows that a large amount of environmental and
environmentally-related information exists in Rwanda. However,
effective use of this information is likely to face a number of
problems.

-      First, the information is widely dispersed and often
unavailable. Maps and data bases of likely interest to MINETO are
held in at least twenty different departments. WRI was unable to
visit every department and a number of departments (notably the
Office Rwandaise de Tourisme et des Parcs Nationals) probably
hold useful information. More problematic than this dispersion is
the attitude of many of the officials interviewed by WRI, many of
whom were surprised that staff from other ministries might be
interested in information they had collected. Catalogues, reports
and other documents were often unavailable, and when available
they usually had to be returned because so few copies had been
printed.

Second, information has been collected at diverse scales, in
diverse manners and usually without reference to the information
needs of other departments. As a result, few data sets are
compatible, either spatially or temporally. For example, the
marais inventory needs local hydrological data in order to run
mathematical models predicting the likely downstream impact of
draining or otherwise interfereing with the marais. However,
these data are unavailable because the hydrological network only
covers the major catchments. Until this network is expanded to
cover more of the 333 catchments mapped by the marais inventory,
it will be impossible to accurately predict the environmental
consequences of the marais development. The peat inventory is
likewise unaware of the marais study, despite the fact that the
peat is entirely contained within the marais.

Third, the priority for most projects has been to produce a
statistical base line in order to inform development plans.
Generally speaking there is are no plans to collect information
on a regular basis. For example, the mandate of the Carte
Pédologique de Rwanda is to make soil maps, not to monitor long
term changes in soil fertility, even though they are the
institute best equipped to do so.

Fourth, few maps or data bases incorporated strictly environmental variables. However, a number of departments would like cooperate with MINETO in their own work. For example, the Direction Generale d'Eau is interested in collaborating with MINETO in monitoring water quality. Similarily, the marais inventory would like assistance from MINETO in developing a more environmentall sensitive set of indicators for determining areas of possible marais development.

Fifth, of all the maps we saw, only the soil maps had been digitized. In order to visualize socio-economic phenomena it is very useful to be able to automatically generate maps down to at least the commune level. Both the Projet Assistance à la Planification Nationale and the Service Nationale de Recensement draw all their maps by hand, with the latter in the process of manually joining and reducing their set of 43 1:50,000 maps to create a new set of 12 1:100,000 maps. Not only is this work very slow, but the absense of a commonly accepted, digitized administrative base map is likely to impede the ready exchange of data and ideas. This is well understood by the groups involved. In fact the marais inventory offered to share with MINETO the cost of a plotter in order to speed progress in the use of computer map making.

Finally, a number of the offices we visited lack sufficient budgets and staff to adequately maintain their data collection and mapping programs and to fully analyze the data. By and large, the best programs were those that received specific project funding from donors.

Task 2.   Proposed Indicators.

Indicators for policymakers can be defined as a set of key statistical series, that can be used to track conditions and trends in the environment, that have important social, economic, and ecological value, and that can be communicated effectively to a user audience. Of course indicators are also useful for managing resources, assessing plans, programs, and projects, and indicators are valuable tools in research. In many cases the same kinds of statistical indicators can be used for all of these purposes. Accurate, timely, useful indicators on soil fertility, for example, can be developed at the farm level for use by the farmer and the local extension agent, and, given adequate sampling and data gathering procedures, these same indicators can be used to assess the effectiveness of a land conservation project, a communal soil conservation program, and the soil fertiliity and conservation aspects of a national strategy such as the Plan d'Action Environnemental (PAE). Environmental quality and natural resource indicators add an important dimension to policy discussions that is not available from using only economic and social indicators.

Three kinds of indicators are discussed and reviewed below.

1. Indicators of Environmental Conditions and Trends.

Every country needs a set (or sets) of national environmental quality and natural resource indicators. Rwandans have compiled a number of indicators and are using these to assess their environmental problems and set goals. The list of indicators shown in Table 3 were taken directly from the Diagnostique of the SNER/PAE.

However, as a quick review has shown, the list is not adequate and considerably more work needs to be done: to improve the statistical quality and geographic coverage of existing indicators; to fill missing gaps in subject coverage; to develop time series so that important changes can be analyzed; and, to communicate these indicators to policymakers and the public so they can be used.

Based on a comparison of the supply of data and the demand for indicators, as expressed in the SNER/PAE, there are five areas in which new or improved indicators should be developed: soils, forests, natural disasters, water quality, and wildlife and biological diversity. In Table 4, we've identified sample indicators, units of measure, and possible sources. For each indicator, it is necessary to look at trends in the condition, extent, and use of the resource and that requires, in many cases, an institutionalized environmental monitoring program. This is a preliminary list. A more definitive plan for developing new indicators for Rwanda should be developed which includes further research in index development and an intensive review of their feasibility and utility.

2. Program Implementation and Management Indicators.

MINETO will also need to develop a set of indicators to assess progress in the implementation of the Strategie Nationale de l'Environnement au Rwanda et du Plan d'Action Environnemental (SNER/PAE). A preliminary list of management indicators, shown below in Table 5, is based on an initial review of the SNER/PAE.

Clearly, merely indicating the completion, date, and cost of actions is not particularly valuable in helping policy makers keep track of their ministries. It will be necessary for the staff of MINETO to develop a more detailed tracking and reporting system to ensure that the Minister and other officials and the public are able to assess progress towards stated environmental goals and objectives contained in the SNER/PAE. This requires breaking down major actions into clearly divisable projects.

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Table 3. Environmental Quality and Natural Resource Indicators Used in the SNER/PAE

Population and Human Development:

    Population, rate of growth, distribution by prefecture and
commune, population mobility, immigration and emigration, fertility rate,
population projections.
Population density, urban and rural growth, number and size
of households, distance between rural households.
Life expectancy, infant mortality, calories and protein as
percent of standard levels.
Population with access to safe drinking water and sanitation
adult literacy, male and female; primary, secondary, and
university training.
Couples with access to family planning services.

Climate and Natural Disasters:

    Precipitation (average and variability), flooding events,
drought events, economic costs and lives lost.

Land Use:
    Agricultural land, pasture land, fallow land, forest land,
park land, urban land, marais, other land, lakes and
rivers.

Agriculture:
    Agricultural (livestock and crop) production indexes,
ag productivity.
Land under crops, land use by size of farm.
Inputs: fertilizer imports, pesticide imports.
Land protected by type of conservation practice.

Forests and Woodland:
    Forest area, forest area by type, reforestation.
Fuelwood production.

Parks and National Forests:
    Area, populations of selected species, visitors, revenues
and expenses.

Lakes and Rivers:
    Area and volume of major lakes (Kivu), fish catch.
water availability, water resources, water withdrawals
by type of use.

Energy:
    Total consumption, fuelwood consumption, use by sector.
Hydropower potential and production, imports.
Methane production (Lake Kivu).
Peat production.

Mining:
      Mineral production.

Transportation:
      Roads, vehicles, passengers, freight.

Source: SNER/PAE Vol. I: Diagnostique.

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Table 4. Selected List of Priority Environmental and Natural Resource Indicators

Resource:	Units of Measure:	Possible Sources of Data:
Soils		
1. Soil fertility.	Index of fertility based on common chemical indicators.	Soil mapping, DSA surveys.
2. Soil loss.	Tons of soil/ha/yr.	Special studies.
3. Area under protection.	Total ha, % of farm land.	DSA, commune statistics:
Forests		
1. Area of natural forest.	ha.	Forest inventory, special surveys.
2. Condition of natural forest.	Index of degradation, index of fragmentation.	Forest inventory, special surveys.
3. Area of forest plantation.	ha.	Forest inventory special surveys.
4. Density of agroforestry.	Trees/ha on farms.	Forest inventory, DSA.
5. Sustainable forest production.	Index of sustainable forest production; ha sfp/ha forest.	Special survey DSA.
Natural Disasters and Hazards		
1. Volcanic activity.	Geological indicators, early warning indicators.	Geological research service
2. Land slides.	events; damage/econ value, lives lost.	Commune statistics.
3. Flooding.	Events; damage/econ value, lives lost, area at risk; peak flows, measure of flow variability.	Topography, census of population, soils mapping.
4. Drought.	Events; damage/econ value, lives lost, area at risk.	Meteorological data.

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Water Quality

1.	Water quality.	Index of biological integrity; other indicators of chemical, bacteria, nutrients, sediment, toxic metals.	New water quality monitoring program.

Wildlife, Biological Diversity, Fisheries

1.	Plant species.	Number of species, number of endemics, number threatened.	IRST, Red Data Books.
2.	Animal species.	Number of species, number of endemics, number and populations of threatened species.	ORTPN, wildlife censuses (e.g., gorilla)
3.	Number of threatened species utilized.	Economic value from: consumption, tourism.	ORTPN, DSA surveys.
4.	Fisheries.	Fish catch in tons, catch/sustainable supply index of fish species in use, econ value of catch.	Fisheries service records.

Source: MINETO/WRI

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Table 5.   Indicators for Managing Progress in Achieving the Goals
           of the Strategie Nationale de l'Environnement au Rwanda
           et du Plan d'Action Environnemental (SNER/PAE)

           Strategies: Indicators:

1.   Establish the National   Completed; year; cost.
      Council on the Environment.

2.   Organize the Technical Committee   Completed; year; cost.
      and the Prefecture and Commune
      Environmental Management
      Committees.

3.   Pass national environmental   Completed; year; cost.
      legislation.

4.   Establish monitoring system   etc.
      to ensure adherence to
      the law.

5.   Establish the Environment
      Fund.

6.   Complete Action Plan for the
      Conservation of Forests
      on the Zaire-Nile Divide
      (other action plans).

7.   Make available information
      for assessing the state
      of the environment.

      Develop system of information
      to support environmental impact
      assesments.

      (Other information systems
      and studies.)

8.   Etc.

Source: SNER/PAE, Volume II: Strategie.

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3. Indicators of Performance and Program Impact

A third type, performance indicators, can help policy makers and the public assess how effectively the government and other institutions are at achieving stated goals and targets. For example, is Rwanda meeting the goals of providing access to safe water and sanitation services to households? This can be measured in terms of the number of households with adequate service. Is Rwanda reducing its soil erosion rates by 20% over a 10 year period while maintaining or improving agricultural productivity? Is Rwanda protecting a sufficient amount of wildlife habitat in order to maintain viable populations of valuable plant and animal species? In each case, not only is there a stated goal for the country to pursue, but there are targets for achievement worked out according to the economic, political, and ecological conditions of the country. Moreover, has progress in implementing programs had a measureable impact on achieving goals of sustainable development, namely improved well-being.

As Rwanda begins to work out a series of targets for achievement and the norms and standards needed to assess progress towards targets, the development of these indicators will become easier and more straightforward.

Task 3.   Options for the Development of a National
          Environmental Information Center

The objectives of the Rwandan SNER/PAE are: to help create a dynamic equilibrium between population and resources while conserving natural ecosystems; to contribute to socioeconomic development in a way that is harmonious and sustainable; and to protect, conserve, and value the natural environment which is indispensable for achieving national social, economic, scientific, and cultural plans.

The Ministry needs information to carry out its mandate and to inform the public. This requires data and information in support of the following activities:

o   to prepare national reports on the state of the
     environment;
o   to prepare a set of national level environmental and
     natural resource indicators;
o   to support investment and development plans such as the
     pilot project in Mukingo that would strengthen that
     area as a "pole de developpement";
o   to monitor and assess the performance of the Rwandan
     SNER/PAE;

o   to prepare plans for projects that will make up the Environmental Action Plan and be integrated within the "programme d'investissements public" (PIP);

o   to assist in developing models that can be used to analyze the interactions among population growth, agriculture production, and the environment;

o   to prepare national legislation for the environment;

o   to support the preparation of various environmental policies, regulations, and other command and control rules and procedures;

o   to support environmental awareness campaigns;

o   to monitor the need for and preparation and implementation of environmental impact assessments;

o   to monitor the major environmental implications of all major development projects in Rwanda;

o   to participate effectively in international and global discussions and policy fora;

o   to report on and comply with all international and bilateral treaties and conventions dealing with the environment;

o   to support and promote environmental education; and,

o   to support and promote effective environmental research on serious problems that are facing the nation.

This is a substantial list of activities and requires a considerable amount of environmental information.

How can a new Ministry with limited budget and personnel be expected to meet its information commitments to the government and the country? Obviously, it is necessary to develop a plan of action and establish priorities.

Principal Activities of the NEIC

Because of the central place information plays in the development and implementation of environmental policies, the consultants are proposing that a National Environmental Information Center (NEIC) be established within the Ministry. The purpose of the NEIC will be to provide the best available information to policymakers concerned with managing and protecting the environment. The NEIC will be expected to work closely with other divisions in the Ministry and with other ministries and the private sector. The NEIC should be responsive to the needs of policymakers while at the same time retain a highly credible reputation for the compilation, analysis, and reporting of environmental information to the public.

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There are four principal activities that need to be addressed in the operation of the NEIC within the Ministry. These are: documentation and retrieval services: environmental monitoring (data collection): data analysis and mapping, including the development of indicators; and raising awareness and reporting. It is essential that the ministry recognize the importance of each of these functions and begin to plan for their implementation.

1. Documentation and Retrieval

This activity requires the compiling of documents, reports, and other information from ministries, universities, NGOs, and other national, local, and international sources. The material should be classified, catalogued, and stored for easy access. The documents collected in the process of taking an Inventory of Environmental Information provides a good start. Materials should be made available to other staff within the Center and the Ministry.

Ideally, the documentation center will become a reference center for the public. This should be the first place people go to find about environmental information in Rwanda. It is not essential that this unit have all information materials in the office, but it is essential that the staff know how to get access to materials. It would be useful if this unit could have access to computers and bibliographic and database management software so that it can develop a database for retrieval of documents and abstracts.

The principal output of this activity will be retrieval services that support policy analysis, special studies, and the proper functioning of the NEIC and MINETO as well as provide a valuable service to the public.

2. Environmental Monitoring

Environmental monitoring entails the collection of raw data from other ministries, the public, businesses, households, administrative units, or directly from the natural and built environment via satellites, aerial photography, field surveys, or instrumentation. Rwanda has already made a substantial investment in compiling resource inventories, developing household surveys, and compiling data from various administrative units. The data collection activities of the Center should be carried out in cooperation with other ministries, universities, and other research, mapping, and survey institutions.

The Inventory of Environmental Information, begun over the past two weeks by the WRI team in cooperation with NES staff, contains a number of suggestions for ways in which the Center can work cooperatively with other Ministries to collect data that is of value to both organizations. Examples of environmental information that needs to collected includes data on water quality (rivers, streams, and lakes, particularly Lake Kivu), soil fertility and erosion, forest lost, plantation and agroforestry coverage, volcanism, early warning information for floods, droughts, and other natural disasters, and ecological migration of peasants within the country and to other countries. This is potentially the most costly activity of the NEIC and therefore decisions to collect raw data should be made cautiously. This is an area where it is essential that the NEIC maintain a network of allies in other agencies so that information can be shared and opportunities for data collection be identified. A number of Ministries have actually tried to contactthe SNE for help in including environmental variables.

The question of using remote sensing and, in particular, satellite imagery should be evaluated by the staff. At this point it makes sense to rely on facilities and staff in other organizations to carry out this kind of monitoring and the processing of images, but the NEIC staff should be involved in planning these environmental monitoring programs and become involved in data analysis and outreach.

There appears to be one area in which the Center should take the lead in data collection and that is in compiling information about environmental projects throughout the country. MINETO will need to have a thorough grasp of all major sectoral and development projects that may have an impact on the environment, including transportation systems, energy projects, agricultural schemes, industrial location, and definitely management of the marais. Developing and maintaining such a database will be essential to track these projects.

The principal output of this activity will be data needed for making policy and monitoring environmentally relevant activities.

3.   Data Analysis and Mapping

It is essential that the NEIC develop its own capacity to analyze data and compile maps. The Ministry of Environment and Tourism cannot rely solely on the analytical capabilities of others. Only by analyzing data will the Center staff be able to make meaningful judgments about various environmental problems and solutions in Rwanda, and only by analyzing data will the staff be able to make sound recommendations for making improvements in the data.

The NEIC will want to carry out analyses of environmental conditions and trends, make comparisons to norms and standards, develop and digitize maps, and prepare statistical charts and tables, and analyze data. This area of work requires some advanced technological and scientific training. This unit will maintain the Center's statistical and mapping databases, compile sets of indicators, prepare maps, and provide analytical support to the Center and the Ministry.

The staff will likely be called upon to conduct special studies and to cooperate in joint studies with other ministries and other organizations. There should be opportunity to work closely with universities in Butare and Ruhengeri as well as with various international research organizations to develop and apply environmental modelling techniques so that a stronger relationship between policies, actions, and environmental benefits and costs can be anticipated. The data analysis unit should be in a position to provide information for researchers at these institutions and participate in joint projects.

The principal output of this activity will be statistics, maps, and analyses which can become the basis for reports, special studies, and policy studies.

4.   Public Awareness and Reporting

Informing the public about the state of the environment, making them aware of the importance environmental quality has for their economic and social welfare, sharing information about environmental policies and practices with the media, and developing information for informal education is the basic task of this activity. Information that is collected and processed and analyzed, but not used is mostly wasted. Information is a valuable resource and needs to be efficiently and effectively used.

Over time this unit will help to take on responsibility for the preparation of a national state of the environment report, a report on indicators and statistics, support in the preparation of the annual report of the Ministry, and produce documents, guides, and educational material for the public.

The principal output of this activity will be reports, newsletters, education and other materials. Some outputs can be in the form of audiovisual communication, computerized databases, and other forms.

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Options for Setting Up the NEIC

A reasonable strategy for developing the National Environmental Information Center would be to work out a phased approach that depends on level of funding, availability of high quality staff, and the priorities of the Center and the Ministry. One mechanism would be for the Ministry, working with donors, to prepare a project for the establishment of a National Environmental Information Center and present this proposal to the World Bank mission in late May and more formally to the donor meeteing in September.

The three Options outlined below are based on increasing level of effort. All staff will be expected to work with computers and receive in-house or local training in computers and the software they need to carry out their tasks. This adds a degree of equality to the staff. Only GIS training would require time away from the office. The staff would be expected to work in a cooperative fashion. The principal staffing requirement is that the professional staff have strong backgrounds in social science or natural science, have some experience with statistics and data analysis and be inquisitive, committed, and work hard. It is not essential that they have prior computer experience.

Option 1: Low Level of Effort.

This option would provide for a simple documentation center and staff to compile and summarize available information related to the state of the Rwandan environment and natural resource base. There would be no environmental monitoring and minimal analysis.

Staffing: two professionals and one junior staff.
Hardware and Software: three PC/386, one
    laser printer, one duplicator; bibliographic, database,
    spreadsheet, and wordprocessing software.

Option 2: Middle Level of Effort.

This option would provide for a simple documentation and retrieval center, a small data analysis unit, and report writing staff. In addition to the activities outlined in Option 1, this level of effort would provide for the development of an indicator database and the preparation of basic maps and a more compresensive state of the environment report. No data collection would be undertaken, but the NEIC staff, with a modest level of funding (grants), would work with other Ministries to encourage the collection and analysis of important environmental statistics.

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Staffing: four professionals, one junior staff.
Hardware and Software: Five PC/386, one PC/486, one
    plotter, one digitizer, one laser printer, one duplicator;
    software requirements include: Wordperfect, dBase, Lotus,
    Harvard Graphics, CAD or similar mapping program.

Option 3: High Level of Effort.

This option would provide for strengthening the
documentation center so it was able to provide referral services
to the public; develop a small environmental monitoring unit that
would provide a higher level of support for collecting and
processing of environmental data; expand the data and mapping
analysis unit to include GIS analysis; and expand the education
and reporting unit.

Staffing: six professionals, two junior staff, one administrative
Hardware and Software: Nine PC/386, one PC/486, one plotter, one
    digitizer, two printers, one duplicator; software
    requirements include: Wordperfect, dBase, Lotus, Harvard
    Graphics, CAD or similar mapping program, and Arc/Info or
    similar GIS program.

Implications for Establishing the NEIC

Implementing the plan to establish a National Environmental
information Center requires considerations of staffing, training
collaboration with other divisions, ministries, and international
organizations, budget, modification and support from
environmental legislation, and technical assistance.

Staffing and Training

Director: The NEIC should have a director, who is an expert in
data analysis and has considerable knowledge about the
environment and natural resources. This person should have strong
communication skills, a collaborative outlood, efficient
management skills, and work well with all levels of government.
Education: BA, MS preferred. Training: Short term training for
exposure to information centers in other countries would be
helpful.

Documentation specialist: This person should have an interest in
environment, be familiar with library and information center
activities and demonstrate considerable initiative as well as
organizational skills. Education: Secondary School and some
professional library training preferred. Training: Short term
training in bibliographic software and applications, in-house.

Data Analysts: Senior analyst(s) would have a background in statistical data analysis and presentation and considerable experience carrying out studies. Education: B.A. in social or natural sciences preferred. Training: in-house. Junior analyst(s) would have similar background, but less experience. Education: B.A. in social or natural sciences preferred. Training: in-house. Two of the analysts would receive training in GIS, preferably in French.

Writer/Editor: This person would have primary responsibility for drafting and editing reports. Should have experience in writing, have strong French, and work well with others. Education: B.A. Training: in-house.

Report Production Specialist: This persons works closely with all staff to prepare reports for publication. Should have expertise in wordperfect and understand printing and distribution of documents. Education: Secondary school plus professional training. Training: Professional training as needed, within Rwanda.

Technical Assistance

Technical assistance will be needed to assist in the purchasing and installing of computer hardware and software, training staff in various software programs, assisting in planning data analysis, and in general providing high quality technical support. A young person with a MS degree in social or natural science, considerable experience in computers and software, and with strong French would provide the kind of expert technical assistance we believe is needed to make the Center successful.

Budgetary Support

We estimate the costs of implementing Option 3., over a three year period, to be U.S.$622,000. Included are the following items:

- o   Three years technical assistance ($300,000)
- o   Hardware and software ($35,000)
- o   Training in Rwanda ($6,000)
- o   GIS training outside Rwanda ($45,000)
- o   Purchase of documents, periodicals, and databases ($15,000)
- o   Printing of reports and documents ($30,000)
- o   International travel ($25,000)
- o   Cost of an advisory committee, principally international travel and per diem ($21,000)
- o   Supplies ($15,000)

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o   Cost of supporting environmental monitoring activities
      in other ministries and the initial training and design
      for environmental monitoring in the Center ($75,000)
o   Miscellaneous (5% of the above)

Obviously, implementing the NEIC at the level of Option 2 or
Option 1 would substantially change the budget and
2responsibilities.

Task 4.   Suggested Means to Strengthen Environmental
            Information In Rwanda

The principal means for improving environmental information
in Rwanda is to strengthen the capacity of the Ministry for
Environment and Tourism. It is suggested that establishing a
National Environmental Information Center within the Ministry
would greatly increase the government's ability to collect,
process, analyze, and report on the changing quality of the
environment in Rwanda.

Priority Areas for Programmatic Emphasis

There are a number of ways in which the NEIC can set
priorities for improving and analyzing environmental information:

1.   Focus on the development and use of information for making
      and assessing policy.

This means compiling statistical indicators of conditions
and trends, summary maps, and annotated bibliographies of
projects, programs, and plans. It is not necessary to maintain
large databases of information that are available elsewhere in
the government or in the private sector. For example, there is
no reason for MINETO to maintain all the data compiled for the
marais inventory. Instead the Center can maintain copies of the
major reports, a bibliographic reference to supporting documents,
and maintain summary statistics and maps in an indicator
database. Copies of the three marais databases could be secured
from MINAGRI if a special analysis or study is required.

2.   Focus on information that links environment to important
      social and economic values and information that is
      multidisciplinary and multisectoral.

Make special efforts to compile materials that reveal
linkages between biophysical variables and social welfare. This
includes: compiling summary data on resource stocks and flows and
on the value of resources; compiling information that links
changes in resource conditions to human health, ecosystem

stability, economic value. It is not necessary, for example, to maintain detailed statistics on the daily discharge of water from each of the stations in the national network maintained by MINITRAPE. Instead, MINETO should maintain the summary statistics and link them to measures of precipitation and ground water runoff, to assess long term availability of water downstream.

3.   Focus on improving information in a few key areas.

Developing a set of natural resource and environmental quality indicators will help focus on areas where data and statistics are weakest and most needed. These include:

   o   soil fertility
   o   soil erosion
   o   forest cover
   o   plantation forestry
   o   agroforestry
   o   water quality in rivers, streams, and lakes
   o   sanitation

This is an area of considerable interest to the World Resources Institute and there may be ways to develop cooperative arrangements between the NEIC and WRI to pursue research on some of these indicators. The NEIC staff should also undertake a careful review of the IRST proposed environmental research agenda to identify opportunities for collaboration in improving basic statistics and indicators.

4.   Initiate projects that have a short term impact and are recognized as MINETO projects. Initiate projects that allow the MINETO and the Center to take the lead while developing cooperation with other ministries and other organizations.

In addition to completing the Inventory of Environmental Information, the Center could host a workshop on environmental statistics and invite all ministries, research institutes, and other organizations. There could be four objectives to the meeting:

   o   to distribute copies of the completed draft Inventory
         of Environmental Information to all participants;

   o   to encourage other ministries to present information
         about their environmental statistics and key studies;

   o   to identify data gaps and begin a discussion on how
         they might be addressed;

   o   to develop plans for a compendium of environmental
         statistics for Rwanda.

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The materials compiled from the Inventory and from the workshop will provide the Center with enough material to begin a small statistical database.

5.   Modify proposed national environmental legislation to include mandate to establish the National Environmental Information Center, to provide for its major functions, to require the preparation of a National State of the Environment Report and to develop a set of environmental quality and natural resource indicators.

Integrating environmental information activities within legislation provides a stronger mandate to carry on specific activities. The legislation should also require other Ministries to cooperate with MINETO in the development of environmental statistics, reports, and other information.

Priority Needs for Donor Support

Developing a National Environmental Information Center is an important, but costly activity. The Rwandans have wisely placed the need for high quality information at the center of their efforts to improve the management of their resources for sustainable development. Donor support can come in the form consultations, participation on the advisory committee, provision of hardware and software, provision of data, periodicals, and other materials, provision of in-country and foreign training, international travel, and technical assistance. The largest expense in the Options outlined above is for technical assistance.

Developing a three year project supported by donors would provide the Ministry with the level of funding required to establish a much stronger and viable information program. The project should have clearly defined outputs, schedule, and staffing responsibilities so that both the government and the donors can assess progress and make adjustments as needed. Establishing a six member advisory committee, composed of Rwandan officials, private sector representatives, and international experts, would help guide the Center's work plan, provide a sounding board for major decisions, review reports, and protect the Center from the whims of government and unwarranted criticism from others. Establishing an advisory committee is also an excellent way to develop linkages with UNEP/GRID and GEMS, with neighboring countries and the experience they bring in developing and using environmental information, and with international NGOs.

4. Summary of Conclusions and Recommendations

We are proposing that a new activity be undertaken by the government that would result in the establishment of a National Environmental Information Center in the Ministry of Environment and Tourism. This initiative will require strong support by the Ministry and financial and technical support from the international donor community including USAID. Recommendations and followup actions for each of these organizations is outlined below:

1. The Role of the Ministry of Environment and Tourism

For the past three years, the government of Rwanda has made a considerable effort to develop strategies and plans for dealing with national environmental issues. We recommend that the government establish a National Center for Environmental Information as a concrete step towards bringing about the changes needed. The NEIC would help the Ministry and the country develop and use better environmental information in planning, management, and evaluation through improvements in data analysis, data collection, and outreach. The activities of the NEIC would help the Ministry to set priorities and develop specific policies and programs.

We recommend that a National Environmental Information Center (NEIC) activity be undertaken by the Ministry and that it be funded by the government and supported by the donor community. Three Options for funding the project have been developed. We recommend that the donors support Option 3 with a three year budget of U.S.$620,000. The NEIC should be staffed with people with strong analytical skills in social and natural sciences and with additional staff for documentation, report writing, editing, and production. Computer skills can be learned, mostly on the job. A list of staffing, training, equipment, travel, advisory services, hardware and software, and other requirements has been prepared. We also recommend that this activity secure the services of an expert in computers with strong background in science and French to provide technical support throughout the life of the project.

A phased approach to the establishment of the Center will be required. We recommend that the NEIC start its work by completing the Inventory of Environmental Information begun with the assistance of the WRI consultants and that a Workshop on Environmental Information be planned for the summer of 1992, at which time plans will be developed for the preparation of a draft report on available environmental statistics in Rwanda and priorities set for improving the collection and analysis of environmental data. This approach will produce tangible products and an opportunity for inter-ministerial and private sector cooperation.

2. The Role of USAID (AID/W, AID/Kigali, Natural Resource Management Project)

USAID has supported the development of better information in Rwanda in a number of different sectors: the Division for Agricultural Statistics in MINAGRI, the Census in MINIPLAN, health and family planning information in ONAPO, and biological diversity monitoring through ORTPN and the Karisoke Research Center. USAID has shown a leadership role in helping the government to manage its affairs by strengthening its data collection and analysis capacity. We recommend that USAID continue this role in environmental information, by supporting the establishment of the National Environmental Information Center.

There are a number of ways in which USAID can support the goals and projects of the NEIC:

o   Continue its support for training and higher education, technical assistance, commodity procurement, and local operating costs through the NRMP;

o   Cooperate with other donors at the donors roundtable in November 1992;

o   Encourage the development of the environmental code which can mandate the Ministry to prepare a annual report on the state of the environment, develop a set of natural resource and environmental quality indicators, and require other ministries of the government to cooperate with MINETO in the pursuit of these goals;

o   Take advantage of non-project assistance to initiate policy dialogue and reforms that promote the passage of environmental legislation; and,

o   Provide additional financial support to the Ministry to establish a National Environmental Information Center. USAID is currently funding similar activities in Uganda, Gambia, and Madagascar, and other missions are proposing to expand their environmental information and GIS activities.

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3.   The Role of Other Donors

During a program appraisal mission scheduled for late
September 1992, donors will carefully review plans and investment
needs for the Rwandan SNER/PAE. We recommend that the donors
give serious consideration to funding the NEIC as one of the 20
projects now being proposed.

Donors have individually provided important financial
support to the collection and analysis of environmental
information: e.g., the marais (FAO/UNDP), water quality
indicators (GTZ), water resources (Austria), forests (CIDA),
topographic and soils mapping (Belgium), peat inventory and land
use mapping (EEC), and geological remote sensing (Belgium). Most
of these activities are part of larger efforts to prepare master
plans for development. Support for the NEIC would provide donors
with a means to encourage the continuation of some of these key
data programs and help to integrate and synthesize this
information in ways that make it more useable and useful.

4.   The Role of the World Resources Institute

The World Resources Institute, in cooperation with USAID
Africa Bureau, has established a Natural Resource Information
Consultative Group (NRICG). WRI, in cooperation with this group
of 15 experts in remote sensing, GIS, resource inventories, and
data analysis, has outlined a work program for the remainder of
1992 and fiscal year 1993 that will provide technical assistance
to selected missions in Africa on environmental information
issues, develop case studies in the development and use of
environmental information systems, and assist USAID in helping to
set information system priorities. This mission to Rwanda was
the first of three missions planned for fiscal year 1992.

WRI is proposing to continue to work closely with the
Rwandan government in the planning and implementing of the NEIC.
.This may take the form of participating in further missions to
Rwanda in planning the NEIC, participating in the international
advisory committee to the NEIC, assisting in the research and
development of indicators, and hosting an international workshop
on the development of national environmental information centers.
WRI expects to be involved, through its Policy Consultative
Group, in the Nyungwe forest policy study, in the support of a
community case studies in sustainable development for its From
the Ground Up project, and other activities dealing with
strengthening NGOs.

Annex 1

Objectifs de la Mission:

1. Assistance à la planification d'un programme d'information
    environnementale (EIP) au Ministère de l'Environnement et du
    Tourisme proposé. Les tâches comprennent une assistance aux
    cadres du Service National de l'Environnement dans les
    tâches suivantes:

    A. inventaire et évaluation des sources de l'information
        et des données environnementales; l'identification des
        applications principales.

    B. identification des indicateurs (types des données)
        pour le suivi de l'état de l'environnement; les
        indicateurs de l'efficacité des programmes ayant
        traits a la SNER/PAE.

    C. justification de la nécessité d'un système
        d'information environnementale; un programme de
        suivi de l'état environnemental, y compris la
        télédétection; l'analyse spatiale des ressources
        et des pressions humaines, y compris le
        développement d'une capacité d'un système
        d'information géographique (SIG); les besoins de
        diffusion d'information aux décideurs et au
        public.

    D. discussion et proposition des moyens pour
        renforcer la gestion institutionnelle nécessaire
        afin d'appuyer un programme d'information
        environnementale au Ministère.

    E. discussion des moyens pour renforcer la
        législation environnementale par l'intégration
        d'une section sur la préparation d'un rapport
        périodique sur l'état de l'environnement et les
        indicateurs environnementaux.

2. Assistance à la préparation d'une mission des bailleurs de
    fond qui sera organisée à la fin du mois de Mai. En plus des
    tâches déjà spécifiées, est la préparation des propositions
    d'activités et des estimations du coût préliminaires
    nécessaires pour la mise en place d'un EIP.

3. Evaluation des opportunités de coopération continue entre WRI et le EIP. Les tâches pourraient comprendre:

   A. préparation et vérification d'un ensemble des indicateurs environnementaux appropriés pour Rwanda.

   B. identification des indicateurs de la fertilité des sols cultivés et la liaison des conditions du sol aux techniques culturelles des cultivateurs et aux besoins des mesures de conservation.

   C. provision de l'avis technique au EIP.

Contacts:

1. MINET: le cadre de l'environnement, des parcs et du tourisme.
2. MINAGRI: le cadastre agricole, l'inventaire des forets, la conservation du sol, la carte pédologique du Rwanda.
3. MINITRAPE: la direction de cartographie.
4. MINISANTE: l'assainissement, la qualité d'eau et la pollution.
5. Autres sujets: la pêche, la diversité biologique, le recensement de 1991, la population, l'énergie, la géologie et les mines, la météorologie, la production industrielle, la commerce, etc.
6. Personnel clef de la recherche environnementale (IRST, MSU, UNR), de la politique environnementale et sectorielle, des ONGs, de l'industrie etc.

Annex 2

MISSION - SYSTEME D'INFORMATION ENVIRONNEMENTALE
Dan Tunstall, Jake Brunner, World Resources Institute
1 - 15 mai 1992

1 mai	vendredi	Arrivée à Kigali
2 mai	samedi	Prise de Contact - Service National de l'Environnement et PARN
3 mai	dimanche	discussion avec Directeur du SNE et étude de documentation
4 mai	lundi	réunion - USAID; discussions au niveau du SNE, organisation du programme; discussions avec Jennifer Olson et Christoffel den Biggelaar (chercheurs MSU)
5 mai	mardi	réunions - Direction Statistiques Agricoles; Projet Pilot MSU/GIS; Carte Pédologique du Rwanda
6 mai	mercredi	réunions - Service Cartographie; Projet Inventaire Marais; Projet Stratégie de Conservation des Sols; DG Forêts
7 mai	jeudi	réunions - MINITRAPE, MINIPLAN, MINITRANSCO
8 mai	vendredi	Visite à l'UNR/Ruhengeri (Dept. Géographie); Projet PARN/COSAF (ancien projet RRAM)
9 mai	samedi	Visite - Parc National Volcans - retour à Kigali
11 mai	lundi	Discussion sur "indicateurs"; évaluation des résultats préliminaires
12 mai	mardi	Visite à Butare: ISAR; IRST; Projet Banque Mondiale (Nyungwe); Préfecture Gikongoro
13 mai	mercredi	Préparation du rapport; discussion des résultats avec les agents du SNE
14 mai	jeudi	Réunions de synthèse - USAID et MINET
15 mai	vendredi	Départ à Nairobi

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Annex 3

Mr Daniel B. Tunstall
Senior Associate, World Resources Institute

Mr Tunstall est directeur du programme de l'Information de
l'Environnement et des Ressources Naturelles (ENRI) du Centre du
Développement International et de l'Environnement (CIDE) à
l'Institut des Ressources Mondiales (WRI). L'objectif de ce
programme est de collaborer avec les gouvernements et les
organisations non-gouvernementales (NGO) aux niveaux national et
international afin de mieux recueillir et exploiter l'information
d'environnement et des ressources naturelles à l'appui du
développement durable. Le travail aborde quatre domaines
principales: améliorer les statistiques est les indicateurs;
faciliter l'accès à l'information par la publication des guides
et des bibliographies; analyser les politiques et les stratégies
d'information; fournir une assistance technique aux pays en voie
de développement afin de renforcer leur capacité institutionnelle
pour recueillir, analyser, exploiter et présenter l'information
aux décideurs et utilisateurs.

Les projets récents comprennent: le développement d'un ensemble
de 240 indicateurs des ressources naturelles pour les pays de
l'Afrique Sous-Saharienne; la préparation de <u>Un Guide aux
Rapports Nationaux de l'Environnement</u> pour 1990 et 1992, une
bibliographie des rapports de l'état de l'environnement et des
rapports semblables pour chaque pays du tiers monde; la
préparation de <u>Vers le Développement Ecologique: la Provision de
l'Information Environnementale aux Décideurs</u>, une analyse de la
disponibilité et de la qualité de l'information environnementale
pour l'appui du mouvement vers le développement durable; la
planification et l'organisation du nouveau Centre de
l'Information de l'Environnement et des Ressources Naturelles
(ENRIC) de l'USAID. Avec la coopération du Bureau d'Afrique de
l'USAID, le programme ENRI a mis en place le Groupe Consultatif
de l'Information des Ressources Naturelles (NRICG), un groupe de
spécialistes qui pourrait aider l'USAID et les institutions
nationales afin de renforcer le développement des systèmes
d'information environnementale et l'application des technologies
informatiques appropriées.

Les emplois antérieurs comprennent: Directeur de Recherche pour
<u>Les Ressources Mondiales 1986</u> (WRI) 1984-86; Administrateur de la
planification du Mead Data Central 1986-87; Conseiller pour la
Conseil de la Qualité de l'Environnement, Bureau Exécutif du
Président, et l'auteur de <u>Les Changements Environnementaux 1981</u>
1974-81; Statisticien analytique, le Bureau de Gestion et du
Budget 1970-74, et auteur des <u>Indicateurs Sociales 1974</u>. Mr
Tunstall est diplômé en affaires internationales et en économie
politique de Columbia University et en biologie de Northwestern
University. Mr Tunstall est marié avec deux enfants et habite à
Bethesda, Maryland, USA.

Mr Jake Brunner
Associate, World Resources Institute

Mr Brunner vient d'arriver à l'Institut des Ressources Mondiales (WRI) où il est chargé de la gestion et coordination des activités du Groupe Consultatif de l'Information des Ressources Naturelles (NRICG), un groupe de spécialistes qui pourrait aider l'USAID et les institutions nationales dans la mise en place et la gestion des systèmes d'information environnementale. Le WRI et le NRICG vont collaborer très étroitement avec quelques pays choisis afin de soutenir la mise en place et la gestion de ces systèmes d'information environnementale et des applications de la technologie informatique appropriée.

Mr Brunner a une dizaine d'années d'expérience dans la conception et la mise en place des systèmes informatiques pour recueillir et analyser les données environnementales. Ce travail a été fondé sur deux technologies émergentes: le système d'information géographique (SIG) et la télédétection. Au moyen du traitement approprié, ces technologies pourraient nous fournir l'information précise et à jour sur l'état des ressources naturelles aux niveaux sous-national, national et international aussi bien que l'information sur le taux de dégradation résultant de la pression démographique. Cette information pourrait aider la formulation d'une politique relative à l'aménagement des ressources naturelles.

Les emplois antérieurs comprennent: Professeur adjoint de la télédétection et du système d'information géographique à Imperial College, London University 1989-90; Professeur adjoint de la télédétection et des statistiques à Oxford University 1986-89. Mr Brunner est marié avec deux enfants et habite à Washington, DC, USA.

Annex 4

Inventory of Environmental Information
Rwanda
May 1992

1. Census Data.
2. Socio-Economic Statistics at the Commune Level.
3. Household Agricultural Statistics.

4. Geological Remote Sensing.
5. Soils Survey.
6. Soil Conservation.
7. Peat Inventory.
8. Forest Inventory.

9. Marais Inventory.
10. Meteorological Service.
11. Hydrological Service.

12. Cartographic Service.
13. Cartographic Laboratory, Université National du Rwanda,
    Ruhengeri.

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Ministry of Environment and Tourism (MINETO)
Inventory of Environmental Information

1. Name of statistical or mapping program:
   Service National de Recensement

2. Brief description of the program:
   1991 census.

3. Name and address of organization compiling the data:
   Service National de Recensement, MINIPLAN, BP 46,
   Kigali.

4. Name and title of contact person(s):
   Mme. Fébronie AKIMABERA, Chef de Division.
   Mr. Modeste NSABIMANA, Chef de Sous-Section
   Cartographique Censitaire.

5. Phone/fax number:
   Tel. 76071/75992

6. Principal statistical variables compiled, analyzed or
   mapped:
   Population, age, previous residence, housing
   characteristics, employment, etc.

7. Geographic coverage (national, préfécture, commune, other):
   National.

8. Methods of data collection (administrative records, sample
   survey, instrument monitoring), periodicity of data
   collection (monthly, annual, other), and documentation on
   data collection procedures (quality assurance procedures
   available, other):
   Rwanda isdivided into enumeration districts ("districts
   de recensement"), each covering on average 1,110 people
   or 250 households. While the commune and secteur
   boundaries have not changed significantly since the
   1978 census, the "districts de recensement", which cut
   across secteurs and commune boundaries, have been
   redrawn for the 1991 census. The population of each
   "district de recensement" was estimated before the
   census by comparing population returns from the commune
   Bourgmestre, the consierge de secteur under the
   Burgmestre and the ONAPO demographic survey. In
   adddition to the standard census data, information
   about the number of health care centers, roads,
   schools, etc. for each "district de recensement" was
   collected.

9.   Scale:
     National, prefecture, commune, secteur, cellule.

10. Titles of principal reports, map folios, databases, other
     means of distribution:
     Recensement Général de la Population et de l'Habitat au
     15 Aout 1991: Résultats Provisoires. December 1991.
     Census questionnaire.
     Map of all 145 communes at 1:25,000 showing secteurs
     and "districts de recensement". The Laboratoire de
     Cartographie at UNR, Ruhengeri have the same maps but
     without the "districts de recensement". Similar maps at
     1:100,000 forthcoming.

11. Review of visit:
     The Service National de Recensement is currently
     processing the returns of the 1991 census and the
     60,000 sample post-enumeration survey. To assist the
     survey they have produced a set of 1:25,000 base maps
     for every commune which were intended to help the
     census taker avoid either missing people or counting
     them twice. They are currently in the process of
     manually reducing the 145 1:25,000 maps to a set of 12
     1:100,000 maps.

     Although the Projet Assistance a la Planification (also
     part of MINIPLAN) also collects data at the commune
     level, the Service National de Recensement had no
     knowledge of this project.

12. Implications for MINETO:
     The Service de Recensement currently produces maps by
     hand and are extremely interested in mapping software.
     However, they have no detailed knowledge about how to
     set up a computer-base map making system, although Mme.
     AKIMABERA received a week's training with POPMAP, a UN
     produced mapping program. MINETO could, if suitably
     equipped, take the lead in demonstrating mapping
     software and provide technical support to the Sous-
     Section Cartographie Censaire. For example, mapping
     software could be used to digitally join the set of
     1:25,000 maps and shrink them to a scale of 1:100,000.

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1. Name of statistical or mapping program:
   Projet Assistance à la.Planification

2. Brief description of the program:
   A 1991 study on socio-economic statistics at the
   communal level showed that while the commune might be
   the "cellule base du developpement national", the
   information gathered was very uneven in quantity and
   quality. The study therefore proposed that a new system
   of information gathering be set up to collect socio-
   economic data at the commune level. It was recommended
   that two people, employed by the DG Statistiques,
   MINIPLAN, be designated per commmune to collect data.
   However, because of cost one person has been designated
   per préfécture instead. The quality of the data is
   therefore still variable. Since 1991 this new socio-
   economic survey has been used to assist national
   planning and the development of indicators of
   deprivation for each commune in Rwanda.

3. Name and address of organization compiling the data:
   MINIPLAN, BP **, Kigali.

4. Name and title of contact person(s):
   Hichem BEN CHAABANE, UNDP consultant on national
   planning.
   Jean-Baptiste NYARWAYA, Chef de Division des
   Statistiques Socialles.

5. Phone/fax number:
   BEN CHAABANE
   UNDP, Kigali   MINIPLAN, Kigali
   Tel: 75381/76906   Tel: 75113/75667 x 235
   Fax: (00250) 76263
   NYARWAYA
   Tel: 72038

6. Principal statistical variables compiled, analyzed or
   mapped:
   Population, health and hygiene, education, employment,
   housing characteristics, radio, electricity,
   agriculture, linestock, agroforestry, commerce,
   transport and communication, etc.

7. Geographic coverage (national, prefecture, commune, other):
   Commune, prefecture.

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8. Methods of data collection (administrative records, sample survey, instrument monitoring), periodicity of data collection (monthly, annual, other), and documentation on data collection procedures (quality assurance procedures available, other):
    Data are compiled from each of the 145 communes.

9. Scale:
    Commune, prefecture.

10. Titles of principal reports, map folios, databases, other means of distribution:
    Le Systeme des Statistiques Communale: Evaluation et Propositions d'Amelioration. January 1991. F. Diafouka. L'Indice des Priorites Communales: Un Indice Synthetique du Taux de Developpement des Communes Rwandaises. June 1991. H. Ben Chaabane.

11. Review of visit:
    Since 1991, under a UNDP financed program, a data base of 100-200 socio-economic variables has been assembled for all 145 communes for the purpose of measuring and mapping their level of development. Analysis of these variables is intended to support national development plans for each prefecture on the premise that to understand the development needs of each prefecture it is necessary to know the level of development of each of the component communes. Development plans at the prefecture level include the identification of potential "poles de developpement" which are intended to soak up rural underemployment if a program of farm agglomeration were established. On the basis of their geographically limited economic spheres of influence, however, no towns can yet be considered as candidate "poles de developpement".

    The main difficulty using these variables is the different standard of collection used in different communes. As a result, a great deal of data processing needs to be performed before any analysis is possible. Due to this on-going process of data standardization, we were told that releasing the data set to other ministries or departments would be premature.

    From these variables indicators of development (Indicateurs Synthetique de Developpement Communale) have been computed based on the factor analysis of 18 composite variables (eg, cultivated land area, number of head of cattle, number of telephones, value of bank deposits) drawn from 48 raw variables. The first principal component accounted for two-thirds of the variance of the 18 variable data set. The two variables

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which contributed most to this component were the
number of telephones and the availability of
electricity. A map of the value of the first component
for each commune shows that the poorest communes tend
to be evenly distributed across Rwanda.

The data base was first stored as Lotus files and more
recently as dBase files. Maps have been drawn by hand
for selected variables and there are plans to use
automated map making software.

12. Implications for MINETO:
     Once the data base has been standardized it could
     provide a useful source of socio-economic information
     at the commune level. No other similar information
     exists at this level (the annual DSA household survey
     is only applicable at the prefecture level). These data
     could, in theory, be combined with environmental data
     in a GIS to improve our understanding of the long term
     future of each commune. At the very least these data
     should be mapped and visually compared with maps of
     soil, agricultural suitability, slope, etc. No
     environmental variables have been collected although
     even a very rough measure of environmental constraint
     such as altitude was thought likely to be of
     considerable help in understanding the development
     prospects of each commune. MINETO could recommend
     suitable environmental variables which might improve
     the analysis and development of indicators at the
     commune level.

Ministry of Environment and Tourism (MINETO)
Inventory of Environmental Information

1. Name of statistical or mapping program:
   National household agricultual survey.

2. Brief description of the program:
   8Since 1984, the Division des Statistiques Agricoles
   (DSA) has undertaken a national household survey,
   collecting data on food production, including yields of
   particular crops, livestock, prices, demographic
   characteristics, land use, etc. In addition to these
   longitudinal studies, the DSA has also undertaken
   special studies at the bequest of ministries, donors
   and NGOs. Recent studies include: problems facing
   coffee production, techniques for improving root crop
   production and the state of agroforestry. These data
   are statistically significant at the préféctural level;
   they cannot be used to describe communes.

3. Name and address of organization compiling the data:
   DSA, Direction Générale de Forêt, MINAGRI

4. Name and title of contact person(s):
   Mr. Anastase MUREKEZI, Directeur DSA.
   Dr. Dan Clay, Michigan State University
   Dr. Scott Leveridge, Michigan State University

5. Phone/fax number:

6. Principal statistical variables compiled, analyzed or
   mapped:
   Crop yields, household expenditure, areas of fallow,
   pasture and wood, etc.

7. Geographic coverage (national, prefecture, commune, other):
   National, préfécture.

8. Methods of data collection (administrative records, sample
   survey, instrument monitoring), periodicity of data
   collection (monthly, annual, other), and documentation on
   data collection procedures (quality assurance procedures
   available, other):
   Data have been collected each week for 1248 households,
   located in 70 of the 145 communes. In addition to this
   longitudinal study, the DSA has also undertaken special
   studies at the bequest of other ministries and donors.
   Recent studies include: problems facing coffee
   production, techniques for improving root crop
   production and the state of agroforestry.

9. Scale:
    n/a.

10. Titles of principal reports, map folios, databases, other
    means of distribution:
    See Liste de Publications de la Division des
    Statistiques Agricoles (DSA), February 13, 1992.
    Contains both list of official reports and working
    papers by the staff. See also Fighting an Uphill
    Battle: Demographic Pressure, the Structure of
    Landholding, and Land Degradiation in Rwanda, Daniel C.
    Clay, May 1992. Draft version.

11. Review of visit:
    The director was very clear about the measures needed
    to increase yields on hilly terrain. The land needs to
    be terraced with strips of cultivated land, interspered
    with trees, separated by and equal amount of fallow
    with lines of trees bordering the fallow strip. The
    trees would provide food, fodder and energy. Currently,
    the lack of fodder forces farmers to pay for his
    livestock to be taken further and further away to
    graze. Not only is this expensive but the supply of
    manure is reduced. Similarly, the absence of fire wood
    forces the farmer to burn crop waste products, rather
    than use them to produce compost. The limited input of
    both manure and compost has, over time, significantly
    reduced the organic content and nutrient supply to the
    soil. As was pointed out, however, the problem now lies
    with persuading farmers that their long term interest
    lies in terracing, composting and planting trees now,
    despite the fact that this would mean a short term drop
    in the cultivated area and therefore a decline in
    income.

    When asked about what new data sources might help the
    DSA, the director discussed the use of satellite data
    to provide a regular inventory of the nation's natural
    agricultural resources, and the provision of long term
    meterological information to warn of the potential
    impact of damaging climatic events such as the current
    southern African drought.

12. Implications for MINETO:
    Attempts to combine the DSA data with environmental
    data within a GIS, has been strongly backed by the
    director throigh the proposed Michigan State University

project. However, the sample size precludes the use of these data at a finer resolution than the préfécture. Since most environmental data are collected at much higher resolution, results based on integrating the socio-economic and environmental data would be statistically meaningless.

MINETO could take advantage of DSA's expertise in data collection by either incorporating MINETO's own environmental variables or by commissioning the DSA to do special surveys.

Ministry of Environment and Tourism (MINETO)
Inventory of Environmental Information

1. Name of statistical or mapping program:
   Carte Pédologique du Rwanda.

2. Brief description of the program:
   Soil survey (classification, mapping and chemical analysis; soil capability interpretation and agricultural suitability mapping.

3. Name and address of organization compiling the data:
   Carte Pédologique du Rwanda, B.P. 74, Kigali.

4. Name and title of contact person(s):
   Dr. GALEZ, Chef du Projet.
   Dr. In. Gilbert MAESSCHALCK (Mapping/GIS).
   In. A. DEFLANDRE (Soil laboratory).

5. Phone/fax number:
   Tel. 73567

6. Principal statistical variables compiled, analyzed or mapped:
   Standard physical and chemical soil indicators; agricultural suitability.

7. Geographic coverage (national, prefecture, commune, other):
   National.

8. Methods of data collection (administrative records, sample survey, instrument monitoring), periodicity of data collection (monthly, annual, other), and documentation on data collection procedures (quality assurance procedures available, other):10,000 soil samples have been analysed from several thousand soil pits.

9. Scale:
   1:250,000 and 1:50,000.

10. Titles of principal reports, map folios, databases, other means of distribution:
    1992 soil map, 43 sheets at 1:50,000, of which 8 have been digitized (see below). These are not yet available.
    1992 1:250,000 soil map which is currently being printed in Belgium.

The description of some 10,000 soil samples are on a SPSS computer database. The CPR has also published a soil data bank with full description of the 276 soil series present in Rwanda collected 1984-88.

11. Review of visit:
Since 1981, the CPR has been an autonomous Belgian-financed group within MINAGRI with a staff of 20-30. The CPR has nearly finished mapping the soils for the entire country at a scale of 1:50,000. Field work was completed in 1984/88 and the maps were prepared for publication during 1988/90. A 1:250,000 soil map based on these data is currently being printed in Belgium. A 1:250,000 agricultural suitability map is being completed based a modified version of the 8 USDA soil classes. A few agricultural suitability maps have been produced at 1:50,000. Comparison between these maps and the crop distribution showed that the farmers knew perfectly well which soils were best for growing different crops. There is no plan to do a follow-up survey in order measure patterns of changing (declining) soil fertility.

Of the 43 soil 1:50,000 maps that make up Rwanda, 8 have been digitized using Arc/Info. The CPR also intends to digitize the complete set of accurate 1:50,000 topographic maps for inclusion into Arc/Info. A sample topographic "layer" has been sent to Belgium for automated contour tracing. Once the contours have been traced they can be treated as a vector file or converted to a raster digital elevation model (DEM) by Arc/Info. Once a DEM has been produced, it can be combined with other layers for the purposes of data visualization (e.g., perspective views of the landscape) and data analysis (e.g., runoff prediction and water balance modelling). Access to the full set of 1:50,000 topographic layers, however, is currently restricted because of security considerations, although the CPR believes it can overcome these difficulties. Acquiring the complete set of 43 topographic layers would be an important precedent since a number of other services need digital topographic data for their own mapping purposes.

The purchase of Arc/Info was originally opposed on the grounds that digitizing the initial map takes significantly longer than it takes to draw the map by hand. Although this is undeniably true, the CPR were convinced that using Arc/Info was worth the additional initial effort because the huge amount of time saved when maps need to be edited, revised and reproduced. Arc/Info is therefore being used as a sophisticated

mapping tool. However, the CPR is also interested in using Arc/Info to compute correlations between different layers from which indicators of agricultural suitability can drawn. To the extent that the CPR is on the verge of becoming the first GIS-based institution in Rwanda, it is worth taking a closer look at the software, hardware and investment in training needed to establish such a center.

The CPR is extremely well equipped to run Arc/Info. The available hardware includes 2 networked 486-based IBM PS/2 Model 90 computers, 2 Calcomp A1-size digitizers and a Calcomp drum plotter. However, even with this powerful computing equipment many data processing tasks take all night. The CPR therefore intends to replace this system by a MicroVAX-based network of SUN workstations. (UNIX workstations are in fact the preferred platform for running Arc/Info.) The CPR has also requested a Calcomp electrostatic plotter. This would allow them to produce color maps publication standard, a quality which they can cannot currently achieve using pen plotters. The CRP has trained two technicians to use the Arc/Info digitization module and can draw on a large skilled staff for the extremely laborious tasks of data verification and map digitization. The two technicians are going to be sent to Belgium for comprehensive training with Arc/Info.

Belgian cooperation intends to finace a follow-on project which would further strengthen the CPR in the following areas: construction and equippment of a new soil laboratory and office space for the service at a cost of $1.5 m; further analysis and mapping of soil suitability using Arc/Info; support for the soil conservation program; support for additional mapping services and cartographic surveys; collection and analysis of soil loss factors using a set of Wischmeier plots.

12. Implications for MINETO:
Although the CPR may represent an excellent case study for the development of GIS technology, it is not a center that the SNE should necessarily try to emulate. The CPR has been well financed and is only mandated to accomplish a few specific tasks during the last phase of the project. The SNE should try to take advantage of the CPR's expertise and facilities by: arranging for the CPR to give workshops and technical advise on how to implement a GIS within Rwanada; and arranging for other ministries to use CPR's digitizing and high quality color reproduction equipment for production of their own maps and reports. The CRP may also be willing

to provide Arc/Info training although they observed
that trainees often prefer to travel abroad because of
the greater legitimacy it confers on their training.

Ministry of Environment and Tourism (MINETO)
Inventory of Environmental Information

1. Name of statistical or mapping program:
   Evaluation of soil conservation techniques and strategies.

2. Brief description of the program:
   Starting in 1990, this FAO supported project has two
   objectives: to inventory soil conservation methods
   throughout the country and to develop a national blueprint
   for soil conservation that fits within the National
   Environmental Action Plan (SNER/PAE). Phase I, now going on,
   is concerned with assessing available information,
   conducting pilot projects to understand effects of farming
   practices on soil conservation. Phase II will start in 1993
   and focus on developing a planning framework and outreach
   materials. Phase III, the operational and implementaltion
   phase, is still two years away.

3. Name and address of organization compiling the data:
   Stratégie Nationale de la Conservation des Sols, Direction
   de la Gestion Rurale et Conservation des Sols, MINAGRI, B.P.
   1502, Kigali.

4. Name and title of contact person(s):
   Mr. Aaron MAKUBA, Direction Générale du Genie Rurale et de
   la Conservation des Sols.
   Mr. Frank BERDING is principal technical advisor.

5. Phone/fax number:
   Tel: 76323/75422

6. Principal statistical variables compiled, analyzed, or
   mapped:
   Eight major studies were undertaken to assess knowledge and
   data on soil fertility, erosion, terrassing, various
   agricultural practices to maintain fertility, seismic
   disturbances (tremors) and land slides, geology and risk of
   land movements, conservation of soils and improvements in
   fertility, and perceptions and opinions of various leaders,
   institutions, NGOs, etc. A special study is being done on
   soil erosivity.

7. Geographic coverage (national, prefecture, commun, other):
   National. See papers for special areal coverage.

8. Methods of data collection (administrative records, sample
   survey, instrument monitoring), periodicity of data
   collection (monthly, annual, other), and documentation on
   data collection procedures (quality assurance procedures
   available, other):

No original data compiled. Quality of the studies varies.
The studies and results were presented and criticized during
two technical workshops and seminaires. Prefectoral meetings
were also organized in each préfecture over the past year.

9.   Scale of resolution (maps):
      n/a.

10.   Titles of principal reports, map folios, databases, other
      means of distribution:
      See list of 7 reports, all should be available in NES
      library; eighth study being published. See results of
      national workshop in Kigali in June 91. Similar workshops
      being held in 10 prefectures. See results of national
      seminar held in February 1992 with recommendations by 4
      commissions which will form basis of the strategy.

11.   Review of visit:
      MAKUBA is very supportive of this project. BERDING is
      enthusiastic and knowledgeable. Main findings to date: (1)
      Main problem is soil fertility (even more than erosion,
      although often problems are in combination) soils so acidic
      in West and North that cannot regenerate fertility once top
      soil is lost without expensive liming and manure. Aluminum
      toxicity is often high. Traditional ag required few inputs
      and top 10 cm of field held best soils. With rapid increase
      in farms and farmers and reduction in fallow period,
      fertility reduced, soil erosion moves better soils to lower
      part of fields. Should plant less demanding crops on upper
      soils and more demanding on lower soils. (2) President's
      insistence in 1986 that program to protect all lands be
      completed by 1988 meant single approach to drainage and
      conservation, which often did not work. Ditching on steep
      slopes increased runoff causing rills and gullies and
      distances were too great between ditches. (3) Intensive
      review of erosivity finds that the average R-factor for
      rains in Rwanda is about 250, which means rain in Rwanda is
      not inherently excessive cause of erosion. Other factors
      (tillage, cropping, harvesting, etc.) are important.
      BERDING is critical of most development projects because
      they are input projects rather than farming behavior
      projects. Need much more farming research and then get NGOs
      to work with farmers and vice-versa to improve practices.
      Need to divorce extension service from any regulatory
      control of farmers and need much more focus on participatory
      extension. See example of Dutch Volunteer Foundation (SNV).

12.   Implications for MINETO:
      This is not strictly speaking a data collection program but
      should be closely followed for information that can lead to
      improved data collection on soil fertility, soil erosion,
      soil conservation practices, farming practices.

Ministry of the Environment and Tourism (MINETO)
Inventory of Environmental Information.

1. Name of statistical or mapping program:
   Direction de la Recherche Géologique et Mines.

2. Brief description of the program:
   Geological applications of remote sensing. Belgian
   financed in cooperation with UNESCO and the Musée
   Royale de Tervurn, Belgium.

3. Name and address of organization compiling the data:
   Direction de la Recherche Géologique et Mines.

4. Name and title of contact person(s):
   Mr. Faustin NYAGAHIMA, Directeur.
   Mr. Timothée RWAGASHAYIJA, technician.
   Mr. Protais NSENGIYUMVA, technician.

5. Phone/fax number:
   Tel: 73504

6. Principal statistical variables compiled, analyzed or
   mapped:
   Landsat TM images.

7. Geographic coverage (national, prefecture, commune, other):
   National, international.

8. Methods of data collection (administrative records, sample
   survey, instrument monitoring), periodicity of data
   collection (monthly, annual, other), and documentation on
   data collection procedures (quality assurance procedures
   available, other):
   Four seven-band Landsat TM images which cover Rwanda
   stored on a 600 MB optical disk.

9. Scale:
   1:250,000 thru 1,100:000.

10. Titles of principal reports, map folios, databases, other
    means of distribution:
    1:250,000 Carte Lithologique du Rwanda 1963.
    1:100,000 Carte Géologique du Rwand 1967.
    1:250,000 Carte des Gîtes Minéraux du Rwanda 1982.
    1:100,000 Plan Mineral du Rwanda, includes geologic
    base map 1987. Funded by BRGB, France.

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11. Review of visit:
The Direction de la Recherche Geologique et Mines houses a PC-based image processing workstation which is being used for geological remote sensing. The workstation includes: a 286-based Wyse PC with 24-bit color graphics capability and a 100 MB hard disk, a SONY 600 MB eraseable optical disk drive, a 12 x 12-inch Kurta digitizer and a Tectronix 4096 thermal transfer color printer. The image processing software, written in Canada, is called PCI. The hardware and software was donated by UNESCO and installed in February 1992. Two members of staff received 4 months training in geological remote sensing and image processing at the Musee Royale de Tervurn which is meant to provide on-going technical assistance. The total cost of hardware, software and training is estimated to be $100,000.

Four cloud-free seven-band Landsat TM images, covering the whole country and all captured in 1986, are available on the optical disk. The precise date of capture was not known.

The TM coverage is especially useful for geological mapping because the extended spectral resolution provided by the near and shortwave infrared bands can often be used to distinguish rocks and soils on the basis of their color and chemical composition. Problems using the image processing software, however, appear to have limited the extent to which these data have been exploited. The two technicians appear to be able to do little more than display a three band color composite and perform a few simple image enhancement functions. Because the on-screen instructions and documentation are in English, the staff clearly have problems using and understanding PCI, despite the fact that they were trained to use this program.

12. Policy recommendations:
Given the fact that complete satellite coverage of Rwanda is available, together with good ground information in the form of recently compiled (1981) geological maps at 1:100,000, such an image processing system ought to be a valuable resource for structural and geological mapping or to anyone handling raster data sets. PCI also has an on-screen digitization function which can be used to draw around the perimeters of different cover type. These polygons can be exported to a GIS where they can be used to update maps. However, until either the staff receive substantial further training or instructions and documentation are provided in English, this agency will

have only limited capacity to make use of the existing
hardware and software.

Ministry of Environment and Tourism (MINETO)
Inventory of Environmental Information

1. Name of statistical or mapping program:
    Inventaire de tourbière (peat).

2. Brief description of the program:
    As part of the overall master plan to develop peat resources
    within Rwanda, they are undertaking a detailed inventory of
    peat resources. This office also collects data on methane
    gas reserves, hydropower plants and electric transmission,
    and other sources of energy.

3. Name and address of organization compiling the data:
    MINITRAPE, B.P. 24, Kigali.

4. Name and title of contact person(s):
    Emile KAREGA, Chef de Service and supervisor of the master
    plan for energy.

5. Phone/fax number:

6. Principal statistical variables compiled, analyzed, or
    mapped:
    Data on peat reserves and resources; location, quality of
    reserves, distance from markets, cost of extraction, etc.

7. Geographic coverage (national, prefecture, commun, other):
    National summary data. Data by specific locations, in
    particular: in the southwest near cement factory; in Nyungwe
    forest; in north next to the Rugizi marsh; the main sources
    in the Nyabarongo wetlands.

8. Methods of data collection (administrative records, sample
    survey, instrument monitoring), periodicity of data
    collection (monthly, annual, other), and documentation on
    data collection procedures (quality assurance procedures
    available, other):
    Using aerial photos at 1:50,000, topographic maps at
    1:50,000, mineral and geological maps, sample drilling to
    determine presence of resource and intensive drilling if
    peat is present. For major reserves, they will develop more
    detailed data and maps at 1:10,000 and 1:5,000. The peat
    inventory is being compiled by Finnish consultant, EKONO,
    under contract to BRGM, France. Also using radiowaves to
    evaluate the depth and volume of the peat bed, allowing for
    better reserve calculations. Use cores to measure quality
    (burn potential). To support the environmental studies, they
    are collecting information on water coverage and
    hydrological features.

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9. Scale of resolution (maps):
   See above description of individual locations and map scale.

10. Titles of principal reports, map folios, databases, other
    means of distribution:
    Tasks and plans for the inventory are contained in a French
    and English report. Need copies.

11. Notes on visit:
    Karega was very interested in the environmental implications
    of peat extraction and burning and sees the value of
    compiling detailed data on the reserves and assessing the
    full environmental benefits and costs of extraction,
    transportation, and use.

12. Implications for MINETO:
    Jean Daniel is working on the environmental impacts of this
    project and knows Karega well. This is a good example of
    MINETO working in collaboration with principal sectoral
    ministry. Further work might also involve colaboration
    between between DG Energie and the marais inventory, water
    resources and forests since the peat covers all three
    domaines. Good test case.

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Ministry of Environment and Tourism (MINETO)
Inventory of Environmental Information

1. Name of statistical or mapping program:
   Inventaire des forêts.

2. Brief description of the program:
   The forest inventory program consists of a number of
   different projects: (1) a national inventory of forests, or
   more accurately a national inventory of wood resources at
   1:50,000; (2) a detailed 1:20,000 mapping of the Nyungwe
   Forest which is being undertaken by four different donors –
   Swiss, French, World Bank, and Canadian – each taking a
   different quadrant and using different methods and
   classifications.

3. Name and address of organization compiling the data:
   Direction Générale de Forêt, B.P. 1003, Kacyiru, Kigali.

4. Name and title of contact person(s):
   Mr. THADEE, Directeur Générale Forêt.
   Mr. RUGOMBUKA, Directeur Production Forêstière.
   Mr. Gilbert BOULAY, Canadian advisor on forest
   management.
   Mr. Francois Xavier NSENGAMUNGU, staff on forest photo
   interpretation and mapping.

5. Phone/fax number:
   THADEE: 85782/82756   RUGOMBUKA: 82619
   BOULAY: 84034   NSENGAMUNGU: 85782

6. Principal statistical variables compiled, analyzed, or
   mapped:
   National inventory; stands greater than .25 ha; microplots
   (mostly used for agroforestry). Variables include: volume,
   number of trees/ha, age, etc.

7. Geographic coverage (national, prefecture, commun, other):
   National; by designated forest.

8. Methods of data collection (administrative records, sample
   survey, instrument monitoring), periodicity of data
   collection (monthly, annual, other), and documentation on
   data collection procedures (quality assurance procedures
   available, other):
   National inventory: 1989-90 1:50,000 aerial photos; Nyungwe
   forest: 1989-90 1:20,000 aerial photos. SPOT panchromatic
   images could be blown up to 1:25,000 to provide periodic
   updates of forest area (but not composition). Note that
   Nyungwe would fall within a single 60 x 60 km SPOT image.

9.   Scale of resolution (maps):
     National: 1:50,000; Nyungwe: 1:20,000.

10. Titles of principal reports, map folios, databases, other
     means of distribution:
     No reports available. Need to get copy of plans.

11. Notes from visit:
     Discussion with Boulay focused principally on the problems
     with previous attempts to map trees and forests: the
     problems with the Technosynesis photo interpretation done in
     1987 with the 1980-82 data: not precise enough, not enough
     ground truthing, inaccurate registration to roads and
     rivers, no checking and no corrections, etc. Problems in
     getting topo maps from Cartographic service;
     inappropriateness of satellite imagery, etc.
     Inventory is expected to take a number of years. Initial
     steps are training 4 staff in photo interpretation, which
     should be completed this summer. Boulay believes full photo
     interpretation could be completed with $150,000; full
     inventory will take $2+ million.

12. Implications for MINETO:
     NES could have substantial role in the inventory process.
     NES could encourage testing the use of satellite imagery in
     measuring the larger forest areas; could assist in promoting
     use of GIS in developing digitized maps; could assist in
     promoting participatory rural appraisal (PRA) in developing
     local level estimates of tree coverage; could participate in
     developing analysis plans; could encourage comparison of
     data with previous years to get time series, could possibly
     participate in training in photo interpretation. A lot to
     explore here.

Ministry of Environment and Tourism (MINETO)
Inventory of Environmental Information

1. Name of statistical or mapping program:
    Inventaire de marais (wetlands).

2. Brief description of the program:
    A joint FAO/UNDP team is spending 2+ years compiling a
    detailed inventory of the resouces of the marais of Rwanda.
    This is Phase 1 of a possible two phase project.

3. Name and address of organization compiling the data:
    Direction Générale du Genie Rural et Conservation des Sols,
    MINIGRI, B.P. 1502, Kigali.

4. Name and title of contact person(s):
    Mr. Aaron MAKUBA, Chef de Division Aménagement Hydro-
    Agricole.
    Mr. Alain GOFFEAU, FAO consultant.

5. Phone/fax number:
    Tel: 83781 (FAO)/75422 (MINAGRI)

6. Principal statistical variables compiled, analyzed, or
    mapped:
    The marais are composed of all lowlands that are wet part or
    all of the year (except lakes). Basically, they encompass
    everything between the hills. The 333 marais making up the
    33 first-order catchment areas have been divided into
    "trançons" occupying 2800 second-order catchments. (Rivers
    divide communes so the same marais may cover two or more
    communes.) Variables compiled for each catchment include:
    agricultural practice, land use, natural vegetation type,
    soil type, fishing activity, gravel and mining, geology,
    slope. See sample form for catchment database with full
    listing of fields. All these variables are stored in dBase
    files. dBase and Clipper are used to process the data.

7. Geographic coverage (national, prefecture, commune, other):
    National, 333 catchment (watershed) areas. From within
    dBase, the extent of marais by commune can be calculated and
    then summed to yield th extent per préfécture.

8. Methods of data collection (administrative records, sample
    survey, instrument monitoring), periodicity of data
    collection (monthly, annual, other), and documentation on
    data collection procedures (quality assurance procedures

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available, other): This is a single time inventory based on existing data, "enquêtes" compiled by agronomes (local ag officials), various maps. See project papers. Goffeau talked about time spent review maps and database for errors and corrections.

9. Scale of resolution (maps):
    1:50,000 marais maps being prepared by hand. The catchments have been drawn off the 43 1:50,000 topographic maps.

10. Titles of principal reports, map folios, databases, other means of distribution:
    1:50,000 marais maps, three databases (primary rivers, first and second-order catchment areas).
    Etude du Plan Directeur d'Aménagement et de Mise en Valeur de la Nyabarongo et de l'Akanyaru. May 1991. SOGREAH.

11. Notes from visit:
    GOFFEAU was enthusiastic about the inventory, its analysis (once completed) and the ongoing management of the marais. Marais are being managed in four ways, measured largely in terms of the degree of drainage: "naturel" (untouched), "emblavé" (some planting and harvesting of crops); "utilizé" (some regular method of drainage is implented, but only enough to control the worst of flooding); and "aménagé" (drained and intensively cultivated). On the basis of this classification, Goffeau estimates that approximately 80% marais in the secondary catchment areas is cultivated.

    GOFFEAU would like to use the inventory to analyze marais for development projects (e.g., he believes most primary river marais should be protected and maintained in mostly natural state); strengthened with more environmental data (need wildlife habitat, species range, water quality measures, etc.) and better hydrological data (the data coming from the 80 stations maintained by the hydrological division of MINITRAPE are deteriorating in quality and flow data. A hydrological model could be used to estimated changes in river flow, flooding, watershed management needs, etc.

    Phase 2 of the project calls for the development of a master plan for the marais. Although Goffeau believes that Phase 1 has been a great success, he needs about $88,000 to complete Phase 1 (the initial inventory). However, UNDP is losing interest in Phase 1 which has so far cost $850,000, and may not support Phase 2.

12. Implications for MINETO:
Goffeau, perhaps more than any other person interviewed, has requested help from the SNE. He would like help with the environmental measurements (they can easily be added to the dBase databases), with improved water data, mapping, digitizing, and GIS help. With a mapping program he can carry out simple analyses of crops produced at the section level and show these patterns on a map. From our visit, this appears to be a solid data compilation program, with promise for policy analysis and considerable opportunity for collaboration.

Ministry of Environment and Tourism (MINETO)
Inventory of Environmental Information

1. Name of statistical or mapping program:
   Diréction Météorologie

2. Brief description of the program:
   Meterological and agro-meteorological statistics.

3. Name and address of organization compiling the data:
   Diréction Météorologie, BP **, Kigali.

4. Name and title of contact person(s):
   Mr. Isaac RUSANGIZA, Directeur de la Météorologie.

5. Phone/fax number:
   *****

6. Principal statistical variables compiled, analyzed or mapped:
   Precipitation, temperature, wind, humidity, etc.

7. Geographic coverage (national, préfécture, commune, other):
   National.

8. Methods of data collection (administrative records, sample survey, instrument monitoring), periodicity of data collection (monthly, annual, other), and documentation on data collection procedures (quality assurance procedures available, other):
   150 weather stations, covering all but 20 communes.

9. Scale:
   n/a.

10. Titles of principal reports, map folios, databases, other means of distribution:
    Bulletin Climatologique (annual).
    Bulletin Agrometeorologique et Phytosantaire (every 10 days).

11. Review of visit:
    Monthly statistics are published in the Bulletin Climatologie based on information from: (1) 150 "postes pluviometriques" which only measure rainfall; (2) of which 24 "stations thermo-pluviometriques" measure both precipitation and temperature; (3) of which 15 "stations synoptiques" measure the full set of meteorological variables. The "stations synoptiques" make daily measurements from which the monthly figures are drawn.

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In addition to the annual bulletin, a Bulletin Agrometeorologique et Phytosanitaire is published every 10 days. This report summarizes the weather over the previous 10 days and the plant health situation (obtained from information gathered from approx. 50 communes) for 9 crops (potatoes, sweet potatoes, manioc, beans, coffee, bananas, etc.). On the basis of this analysis it makes recommendations for the use of particular insecticides and/or cropping practices for each crop. In addition, the 10 day averages for temperature (min, max, soil), insolation, humidity, rainfall, ETP, etc. for each of the 15 "stations synoptiques" are recorded.

Meterological time series are available for all 150 stations from their initiation thru 1981 and 1990-92. The 1982-89 gap will be filled by September 1992. These data are stored using a program donated by the UN called CLICOM. They have used a contour plotting program called SURFER but prefer to draw isohyets by hand because of difficulties using SURFER (which has a reputation for being difficult to use, at least in earlier versions).

12. Implications for MINETO:
The only cooperative work that the Service Météorologie has been involved with was participation within the Groupe de Coordination National du Changement Climatique (GCNCC) which was set up in 1991 and met 3 times. The GCNCC was composed of 20 members drawn from 10 ministries, departments (including the SNE), ISAR, IRST and UNR. However, it has not met since November 1991 because of the current ministerial transitions. In the meantime, MINETO could offer to assist with: analysis of the 150 station climatic time series (once the 1981-88 gap has been filled); investigation of possible cooperation and data integration between the departments of meteorology and hydrology, especially regarding the water balance of the marais; use of MINETO mapping equipment for producing better produced and more informative meterological graphs and maps.

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Ministry of Environment and Tourism (MINET)
Inventory of Environmental Information

1. Name of statistical or mapping program:
    Direction de Hydrologie et Gestion des Ressources en Eau,
    MINITRAPE.

2. Brief description of the program:
    The Direction Générale Eau et Assainissement is made up of:
    the Division Assainissement; the Direction Hydraulique; and
    the Direction de Hydrologie et Gestion des Ressources en
    Eau. The Direction de Hydraulique is made up of: the
    Division d'Etudes et Inspection des Projets; the Division
    d'Entretien et Exploitation; and the Division de Hydraulique
    Urbaine. The Direction de Hydrologie et Gestion des
    Ressources en Eau is made up of: the Division Hydrolique and
    a GTZ financed Laboratoire de Qualité d'Eau. Responsibility
    for inventorying, managing and monitoring water discharge
    and quality is therefore spread across a number of
    Directions and Divisions. Interest in water as valuable
    resource is relatively new and as a result work has focused
    on inventorying both the quantity and quality of the water
    supply. Work has not yet started on monitoring changes in
    water quantity and quality. As part of this process, the
    Directeur of the Direction de Hydrologie et Gestion de
    Ressources en Eau has just drafted legislation regarding
    water quality standards.

3. Name and address of organization compiling the data:
    Direction de Hydrologie et Gestion des Ressources en Eau,
    MINITRAPE, BP 24, Kigali.

4. Name and title of contact person(s):
    Benoit NSENGIMANA, Chef de Division

5. Phone/fax number:
    Tel: 83710, 83704

6. Principal statistical variables compiled, analyzed, or
    mapped:
    The hydrological division collects water discharge data for
    major drainage basins on a daily basis. Number of basins
    varies by year. Other information compiled includes:
    precipitation, amounts and dates of maximum and minimum
    flows, annual discharge, average discharge, average
    discharge per km within the watershed, size of watershed,
    precipitation, surface and groundwater runoff and

percentages of total precipitation. Height of water course is also given. A separate set of data are compiled for major lakes: average, maximum, and minimum height along with basin area. Both sets of data are compiled according to international methods and published annually.

For groundwater statistics in the Nyabarongo river basin see Annex XIII of the May 1991 report. Note bibliography.

Water quality data are being collected for Kigali for some variables. (Need documentation.)

7. Geographic coverage (national, prefecture, commun, other):
    In 1980, reports on discharge data were prepared for 28 major monitoring stations and adjacent water basins and 16 stations that measured water levels in lakes and major rivers; in 1986 reports were prepared on discharge for 15 stations and levels for 19 stations. The 1980 data were published in 1985; it is not clear from documentation when the 1986 data were published. The 1980 data report also contained isohyet maps.

    From others, it appears basic water discharge data were previously collected for a number of smaller areas but these collections have been curtailed.

    For spring resources, they've completed data collection for 9 of 11 prefectures, with maps (scale not known). This was a joint MINITRAPE and UNESCO project. See also information supplied by UNR geography department.

8. Methods of data collection (administrative records, sample survey, instrument monitoring), periodicity of data collection (monthly, annual, other), and documentation on data collection procedures (quality assurance procedures available, other):
    See above for water discharge and water course heighth monitoring. For spring data, need documentation.

9. Scale of resolution (maps):
    Point source monitoring for discharge and levels. Have exact latitude and longitude coordinates for stations which also have an international code.

10. Titles of principal reports, map folios, databases, other means of distribution:
    Annuaire Hydrologique, 1986 Direction Generale de l'Eau
    Annuaire Hydrologique, 1980 Direction Generale du Genie Ruralet de la Conservation des Sols.
    (The above are intended to be annual reports; need further documentation on peridicity and availability of database.)
    Master Plan for Water Resources and Development, 1991. See

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also Plan Directeur et Systeme de Gestion des Ressources en Eau, Termes de References Techniques de La Phase 2, T.B.W. and Annexe A: Document du Project: Plan Directeur et Système de Gestion des Ressources en Eau.
Evaluation Hydrologique D'Afrique Sub-Saharienne, Pays de La CEPGL.
Memento des Normes pour la Qualite d'eau potable du Rwanda (NQEPR), mai 1992: contains listing of water quality standards based principally on those proposed by the WHO. Specific modifications were made to the WHO standards based on special studies.
Arrête Presidential Fixant Les Normes de Qualite Des Eaux de Consummation, le 27 Avril, 1992.

11. Summary of Visit:
Benoit is new to the job, previously worked 5 years in the water resource management section, then promoted. Spent 6 years studying in Minsk and in Hungary and wants to continue training in U.S. in water quality monitoring and management. Rwanda has a set of standards for water quality and has a laboratory (supported by GTZ) to carry out tests. They collect some data on a monthly basis in Kigali (see reports), but apparently do not have a continuous monitoring system. They are looking for funds to support computerization of the data work. (Not clear if they have a database now.)

12. Implications for MINETO:
This is an excellent time to cooperate with this division. Benoit seems interested in the environment and he wants to get some help with water quality monitoring and indicators. His program could provide some of the first good water quality measurements for a state of the environment report. They also definitely need to be brought into discussions with the marais inventory, the soil conservation strategy, and other inventory programs. Phase I of their Master Plan for Water is complete and Phase II is underway supported by the Austrians. More could be done to summarize the water discharge data and plans could be initiated to expand and update discharge monitoring.

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Ministry of Environment and Tourism (MINETO)
Inventory of Environmental Information

1. Name of statistical or mapping program:
    Direction de Cartographie.

2. Brief description of the program:
    Base and topographic mapping.

3. Name and address of organization compiling the data:
    Direction de Cartographie, B.P. 24, Kigali.

4. Name and title of contact person(s):
    Mr. Sylvestre MUNYAKAZI, Chef de Division de Levée.

5. Phone/fax number:
    Tel: 75771

6. Principal statistical variables compiled, analyzed or mapped:
    Topographic and administrative mapping.

7. Geographic coverage (national, préfécture, commune, other):
    National.

8. Methods of data collection (administrative records, sample survey, instrument monitoring), periodicity of data collection (monthly, annual, other), and documentation on data collection procedures (quality assurance procedures available, other):
    Aerial photographs; administrative records.

9. Scale:
    1:250,000 thru 1:2,000.

10. Titles of principal reports, map folios, databases, other means of distribution:
    See map catalogue for 1985 and 1992 (in press).

11. Review of visit:
    The Direction de Cartographie was set up in 1969 and has passed through the hands of four different ministries before finding its current administrative home within MINITRAPE. The DC has a staff of 30, including two technicians. It is not an autonomous group but depends on the ministry for funding. Perhaps as a result of lack of funds the DC can charitably described as "sleepy". The most up-to-date catalogue of available maps is for 1985. A new catalogue is in press but there is no expected date of release because funds have not yet been allocated to pay for the printing.

The primary purpose of the DC is the production of topographic maps from aerial photographs. Aerial photos for the whole of Rwanda have been captured every 10 years or so since the 1950's. The coverage and scale provided by the last two campaigns is summarized below:

Date:	Coverage:	Scale:	No. of Photos:
1989-90	National	1:50,000	900
1989-90	Nyungwe forest	1:20,000	n/a
1989-90	Kigali, Butare, Ruhengeri, Gitarama	1:10,000	n/a
1989-90	Kigali	1:5,000	68
1977-82	National	1:50,000	n/a
1977-82	National	1:25,000	4300
1974	National	1:50,000	n/a
1955-61	National	1:50,000	n/a

All these photos were captured on black and white visible or near infrared film, and the negatives are stored at the Institut National Géographique (IGN), Paris. The 1977-82 1:50,000 photos were used in a Belgian financed project to produce a very accurate set of 43 topographic maps for the whole country. These maps are currently unavailable for sale for security reasons (see review of Carte Pédalogique de Rwanda). The 1977-82 1:25,000 photos were used by to produce a land use map for the whole of Rwanda at 1:20,000. The 1989-90 1:20,000 photos of the Nyungwe forest are being used for a multi-donor financed inventory of the forest. More information about the scope and progress of this project is available from the Direction Général de Forêt. The 1989-90 1:5,000 photos of Kigali are being used to make a 1:2,000 "carte touristique" of Kigali. This is not expected to be finished before 1994.

12. Implications for MINETO:
The availability of cloud-free photos at the same scale 10 years apart could be used to measure changes in land use between since 1955-61. Since 1987 the availability of SPOT panchromatic imagery, which has a spatial resolution of 10 m and can be blown up to 1:25,000, allows in theory the continued monitoring of land use change in Rwanda. However, it must be borne in mind that: (1) it is very rare to capture cloud-free images

and (2) 17 60 x 60 km SPOT panchromatic images, each occupying 36 MB, are required to cover the country. Storing these data would be reasonably cheap but purchasing and analyzing them would be prohibitively expensive. However, continued monitoring from space of, say, the three natural forests (forêt naturelle) would only require 3-4 images and would be a much more practical task.

Ministry of Environment and Tourism (MINETO)
Inventory of Environmental Information

1. Name of statistical or mapping program:
    UNR, Ruhengeri, Department of Geography and Cartographic
    Laboratory

2. Brief description of the program:
    This department and laboratory compile maps of natural
    resources in Ruhengeri prefecture and throughout the country
    on demand and when paid for work. They have prepared
    atlases of Rwanda, of Africa, and do thematic maps at many
    different scales. They also compile original data which
    they map. They have a twinning relationship with the U. of
    Bordeaux which provides technical support, short term
    teaching, and some funds for equipment and training. Major
    emphasis is on teaching students (up to 100) in geography
    and giving them experience in photo interpretation and
    cartography. They have some equipment for map enlargement
    and photo interpretation. No ability to do contour mapping
    (?), no computers, no digitizing, no GIS, but they did
    assist in compiling data and maps for the AID-supported
    R/RAM project.

3. Name and address of organization compiling the data:
    UNR, National University of Rwanda, Ruhengeri, B.P. 44,
    Ruhengeri Prefecture

4. Name and title of Contact Person (s):
    Professor Laurien UWIZEYIMANA
    Professor Federic GATERA (did not meet)
    Mr. Ananias NDIKUMAGENGE, technician of the cartographic
    laboratory

5. Phone/fax number: need to get from Jean Daniel

6. Principal statistical variables compiled, analyzed, or
    mapped:
    This university does not compile data on a continuing basis.
    Examples of special studies and projects completed:
    (1) prepared 1:25,000 maps of all secteurs, communes,
    prefectures within the country, based on 1978 census data;
    have national level map at 1:250,000 and commune maps at
    1:25,000 which they will prepare from transparencies upon
    demand and payment; data elements include boundaries, roads:
    national, communal, and footpaths, marais, etc.
    (2) in 1991, prepared maps of all springs in the country as
    part of UNICEF project, vent de source d'leau, at 1:50,000
    (see also information on water resources): includes data on
    sources (location), management, and resource availability;
    (3) prepared more than 50 maps on natural resources for the

USAID supported R/RAM Ruhengeri Prefecture project at 1:25,000
(4) in 1992, doing 145 commune maps for the MRND at a cost of 100,000 Frw;

They have also prepared at Atlas of Rwanda and Africa, both of which they would like to do again

7. Geographic coverage (national, prefecture, commune, other):
    All. See examples above.

8. Methods of data collection (administrative records, sample survey, instrument monitoring), periodicity of data collection (monthly, annual, other), and documentation on data collection procedures (quality assurance procedures available, other):
    In most large mapping projects, they use student to go out and compile data.

9. Scale of resolution (maps):
    Various. See examples above.

10. Titles of principal reports, map folios, databases, other means of distribution:
    Atlas de l'Afrique, Atlas du Rwanda (no copy available for inspection). ·

11. Notes on visit:
    Led by Uwizeyimana and Gatera, this department and laboratory are apparently equipped and available to compile and map information on natural resources of Rwanda, at all scales. They like doing this work and want to do more, but must be funded outside regular university channels. They lack digitizing and computer processing equipment and have little capacity to duplicate maps and therefore have few examples of their work, having turned over the original maps to donors and other sponsors in the government and donors. They also lack records of the statistics compiled from maps, and without computers have no retrieval databases.

12. Implications for MINETO:
    This group would be able to assist with original data collection that is best done on a spatial dimension such as the water resource data compiled for the joint MINITRAPE, UNESCO project. For example, they could help MINITRAPE develop maps of peat. More importantly, they could maintain a database of thematic maps for the country and work jointly with MINENTOUR on developing plans for future resource mapping projects. (Official maps are maintained by the cartographic service.) See additional information on the MSU project.

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