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Toward Regionally Consistent Data Access and Distribution, Core Data Development, and Internet Applications

Development and Applications of SDI and Public Goods

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Introduction

Advances in Information and Communication Technologies (ICT) now make it possible to obtain data and information from innumerable sources at increasingly greater speeds and larger quantities. Although many have suggested that we now live in a global information economy, it is not clear that the advantages of this global information economy are readily available to the developing world – nor for that matter, that the integration and coordination of these technologies in development strategies or projects is adequate or even seen as a priority. This is indeed unfortunate because information (as organized data and the foundation for understanding and knowledge) may now be, as asserted by Cleveland (1985), our most important, and pervasive, resource. More recently, its value for development has been recognized by the United Nations: “Information and Communication Technologies are now fundamental to dealing with all development issues in developing countries.”

The increased availability of broad band internet services and the availability of affordable software and hardware has coincided with institutional desires both to provide spatial data and to support client applications. The advent of on-line internet services, e.g., data access, internet map serving, querying, analyses and simulations, and even commerce has the potential to distribute the benefits of the technology equitably across countries and out of the domain of technical gurus. However, this potential widespread application will depend upon ready access to meaningful data and information that is user friendly, available at nearly any time, and accessible in nearly any place. Such a widespread spatial data infrastructure (SDI) is a public good.

The extraordinary potential of these technologies and the universality of SDI place a special burden on International Donors. A burden that requires an increased emphasis on data quality, data and projection standards, interoperability, data access, data maintenance, and data distribution. Individual donor-supported projects no longer can produce data and information that have value far beyond the projects’ own use and ignore their responsibility to insure that optimum post-project value is attained. Data and information access is widely acknowledged as a global public good; data standards and data access mechanisms, thus, are an intermediate public good, providing the means with which to achieve the former. Requirements in donor agreements - relatively simple and easily attainable - can insure that these data resources and products truly become public goods.

Sustainable development requires greater attention to these issues if we believe that those who can publish, share, access, integrate, and use information are those who will benefit the most. It also follows that attention needs to be directed to core capacity building to ensure that the maximum public good is realized, that our science and applications become truly sustainable, and that ownership and data maintenance are taken with serious commitment. These needs, both for core data and sustainable capacity building are perhaps greatest in the smallest nation states and the poorest.

This paper presents the results of research and development (R&D) applications in SDI public goods from recent regional activities of the International Program (IP) of the U.S. Geological Survey/EROS Data Center¹ (USGS/EDC). The emphasis is on geospatial data development, data access and distribution, on-line and near real-time applications, and sustainable capacity development. The results of the EDC and the IP applications are seen largely as public goods, that is, those whose benefits are widely available (non-excludable) and whose values are not diminished by unlimited use (non-rival). The SDI applications that are presented are derived from U.S. Agency for International Development (USAID) projects that are both national and regional in scope and focus on Latin America, the Caribbean, and Africa. The projects are also closely related to projects supported by other donors, e.g., the InterAmerican Development Bank and the World Bank, with whom we endeavor to work closely. More specifically, this paper:

- 1. Presents a Vision for a Functional Regional-Global SDI,**
- 2. Examines Project Applications in three Areas of SDI and Public Goods:**
 - 2.1. Spatial Data Development, Access, and Distribution – Geospatial Data Clearinghouses,**
 - IGDN
 - Hurricane Mitch and Accessible Core Data
 - 2.2. Remote Sensing, Consistent Land Cover/Use and Integrated Core Databases, and Internet Map Servers,**
 - 2.3. Prototype Development of Internet Accessible Parcel Certification Systems: Integration of Spatial and Information & Communication Technologies, and**
- 3. GASSIA Workshop and Recommendations to Donors** (Hyman, Lance, and Tieszen, 2002; <http://edcintl.cr.usgs.gov/gassia.html>).

1. A Vision for a Functional Regional-Global Spatial Data Infrastructure

A workshop, *Geospatial Applications to Support Sustainable International Agriculture (GASSIA)*, <http://edcintl.cr.usgs.gov/gassia.html>, of international research and development centers recently convened at the EDC and endorsed and developed the concept of an international and interoperable framework for geospatial data and related spatial and web-based tools. This framework, identified as an Agricultural and Environmental Geospatial Information System (AEGIS), can now consist of a backbone with distributed servers or nodes and innumerable access points from both powerful super computing facilities and inexpensive desktop computers with simple browser capabilities.

¹ The EDC, a World Data Center for Land Cover, has national responsibility for the acquisition, processing, archiving, distribution, and research and applications of remotely sensed data (<http://edcwww.cr.usgs.gov/>). The International Program (IP) of the EDC specializes in research and development projects that use remotely sensed data or geographic information systems to address issues of sustainable development, capacity building, resource management, land cover change, monitoring, disaster mitigation, and early warning systems. (<http://edcsnw3.cr.usgs.gov/ip/program.html>). Specific projects are detailed at <http://edcintl.cr.usgs.gov/iphandout/iphandout.pdf>.

Multiple “gateways” or “portals” to remotely sensed imagery, geo-referenced censuses, national core data, distributed climatology and weather forecasts, related agricultural information, etc. will exist. The gateways will facilitate resource discovery, access, and delivery, but still will allow custodians to retain control over their data and tools. The technology and standards exist to make this an operational reality. What may not yet exist is the commitment to interoperability among all potential participants and the widespread availability of broad and inexpensive bandwidth in developing countries. Better mechanisms still need to be implemented to transfer these data and tools to partners in developing countries; and better feedback mechanisms to gauge impacts for improved decision-making are also required.

The framework encompassed by AEGIS is depicted in Figure 1. This is not merely a pro-GIS initiative; it is a new paradigm for global development because it is about building alliances to achieve efficiency, sharing of information, appropriate intellectual property regulations, and responsiveness to new technologies that are being introduced. We believe the time has come to develop a single interoperable infrastructure, so that data, software, models, tools, and the Internet can be used seamlessly. The overall data infrastructure has consistent **core data** sets from various sources at the base level and will generally include the following:

- Cadastral boundaries (i.e. land parcel),
- Administrative boundaries: national, provincial, local authorities, magisterial districts, tribal authorities, suburbs, planning regions,
- Hydrography: Rivers, dams, catchment areas,
- Infrastructure and facilities: Roads, power lines, pipelines, airports, schools, hospitals, clinics, police stations, post offices, water sources,
- Elevation,
- Land cover, land use, biodiversity
- Demographics,
- Industry/economy,
- Digital ortho-imagery/other national imagery.

Embedded in the ‘**data sources**’ layer are data standards that govern how data are collected, created, and projected allowing integration and re-use. The ‘**access and discovery**’ layer functions as a Clearinghouse and includes structured metadata that describes data sources, allows access, and facilitates distribution/delivery. Dependent on these two layers, are the ‘**modeling, application, and querying tools**’ needed for decision support services. This layer, too, requires standardization, and should produce products that are readily usable for the public good. The services, models, tools, and decision support systems created and available on-line and the data and information from the lower layers together form the basis of the data infrastructure that supports a host of analyses – such as flood forecasting (FEWS NET), food security projections, the effectiveness of in-situ germplasm conservation, modeling land cover impacts, commodity certifications, coffee cupping and sales, agricultural (DSSAT) and biodiversity modeling (Floramap), etc. ‘**Portals, projects and syntheses**’ can now develop that rely on the underlying data infrastructure to provide information, foster interoperability, and convey policies and strategies for better decision making.

2. Project Applications in three Areas of SDI and Public Goods

2.1. Spatial Data Development, Access, and Distribution – Geospatial Data Clearinghouses

Inter-American Geospatial Data Network (IGDN): In 1994, a hemispheric-wide meeting in Cartagena, Colombia, on standardization of spatial data introduced and developed the concept of NSDI (National Spatial Data Infrastructure). This resulted in a request that the Pan American Institute of Geography and History (PAIGH), based in Mexico City and a statute body under the Organization of American States, develop plans to implement the concept among the thirty-five member States. In 1995, USAID funded EDC to provide technical expertise and assist PAIGH in establishing the **Inter-American Geospatial Data Network (IGDN)** and to pursue the NSDI objectives at the hemispheric level, i.e., to begin to establish **Hemispheric Geospatial Data Clearinghouses**; promote the adoption of **standards for data sharing**; and develop **procedures and partnerships**. This grant was also responsive to the 1994 Summit of the Americas' action item to enhance information infrastructure and to increase economic integration in the hemisphere. The IGDN was supporting hemispheric integration with PAIGH through the implementation of geographic information systems (GIS), clearinghouses, and metadata construction implemented with organizational and national support provided by the IDB.

The IGDN projects continued with critical multilateral support by the USAID, Canadian International Development Agency (CIDA), UNEP, and the IDB and resulted in an ambitious program, mainly with national mapping agencies, of geospatial data development, capacity building, and node installations in 10 countries of Latin America. Other support resulted in at least 20 registered nodes in the Caribbean Basin (Figure 2). In addition, other countries and many other agencies have received training, have produced metadata records, and appear committed to further development of their data holdings; and international expansion is continuing (Figure 3). This seminal work was extended in 1997 when the Canadians used the EROS's IGDN-compliant trainers to assist them with developing a series of electronic digital atlases. These atlases provide digitized spatial data to a broad group of users and initiated an expanding database to accommodate new data development for the public domain. Initially designed to operate from a CD-ROM for wide flexibility in use, now components are live on internet-based servers.

What is the current status of these developments and what has been achieved? One of the fundamental capacity building strategies was to develop a team of Latin American specialists through "train the trainer" workshops. . These Latin American trainers (Spanish, Portuguese, and French) in turn, transmitted their expertise to the participating countries through national workshops, where a cascading effect continues within each country to disseminate the technology. Training workshops and national workshops were implemented, and several hundred individuals have been trained. The PAIGH project also refined the metadata software "MetaLite," implemented an on-line thesaurus (quadrilingual for keywords), and provides clearinghouse software, metadata tools, presentations, technical papers, and training materials via CD-ROM in Spanish and Portuguese. Reduced regional support from the IDB prevented complete expansion

across the hemisphere; and Hurricane Mitch redirected subsequent activities. More recent efforts also have focused on metadata/clearinghouse capacity building in Africa. The International Organization for Standardization (ISO) has developed an international metadata standard that most data producers around the world will adopt, thus increasing the critical mass of organizations contributing to the global data clearinghouse network. In the future, USGS/EDC will support a new ISO-compliant metadata tool, Enraemed, developed in Ethiopia with Dutch support.

Hurricane Mitch, Regional Clearinghouses in Central America, and Accessible Core

Data: The infrastructure and rich natural resource base in Central America, already stressed from the effects of rapidly changing land use and growing human population pressure, suffered a major setback due to Hurricane Mitch in 1998. The USGS/EDC responded to the major disasters caused by Hurricanes Mitch as well as Georges with immediate and direct humanitarian assistance and longer-term capacity building, impact assessments, reconstruction assistance, and input to disaster planning and mitigation. The project was implemented following a Mitch-reconstruction meeting early in 1999, convened by *Sistema de la Integración Centroamericana* (SICA) in San Salvador and funded by IDB and WB, which emphasized the need for regional cooperation in environmental management, the importance of planning and land use management, and ready access to accurate geospatial data. Shared boundaries and watersheds emphasized the need for regional consistency and cooperation. It was generally recognized after the disaster that decision makers were hampered by a lack of integrated information on natural hazards and threats to natural resources, particularly information in a geographically consistent format and in useful and easily understandable forms. Unfortunately pre-Mitch implementations of GIS were very project specific, independent, and isolated, thereby limiting the benefits of availability to the broader user community.

The inability to access relevant data; the lack of standards in projections, formats, and maintenance; the difficulty of data distribution; and the lack of **fundamental core data sets** in this specific regional disaster highlighted the need for compatible spatial data infrastructures (SDI). The development and implementation of a consistent SDI would integrate various organizations' GIS and other information systems to create enterprise-wide databases as well as distributed systems with protocols for access and use. This integration allows the participating organizations to achieve more with fewer resources by maximizing data sharing and information flow. Access and compatibility, of course, are especially important in disaster responses. Mitch clearinghouse activities were undertaken cooperatively with the impacted countries to approach these SDI objectives and facilitate both project and national data availability.

The project built on the resources of the IGDN and established an integrated data system (Clearinghouse) to catalog and disseminate geospatial information related to natural hazards in Honduras, Guatemala, Nicaragua, El Salvador, and the Dominican Republic. El Salvador had participated in the IGDN and was able to provide substantial advanced capability and leadership. The system is totally distributed (see Annex 1) with each node, including that at the EDC, <http://mitchnts1.cr.usgs.gov/>, serving as a peer, although the

EDC site contains a redundant set of data and metadata. The national Clearinghouses and associated web sites are repositories for the distribution of data and products generated by the USGS in each country, national and regional data as these are described or developed by each country, and data provided by other donor projects in the region. The Ecosystem Map, <http://mitchnts1.cr.usgs.gov/data/otheragency.html> supported by the World Bank, is an example of the region-wide project that now provides its products and source data from the Clearinghouse.

Each Clearinghouse Web Site features an easy-to-use browsable metadata section and a complete data inventory for each participating institution, graphic depictions of the data holdings, Web mapping capabilities, and links to a gateway. All the information produced, cataloged, or distributed is available on the Web, allowing the user to access data with a simple Internet browser, without the need for special software or broadband connections. The Clearinghouses are fully cooperative and participatory with products developed by the national participating institutions. Technical support, capacity building, hardware and software were provided. In each country each institution chooses its level of participation, ranging from the institution that decides to only present its data inventories and metadata catalog to the institution that decides to also feature some of its data on a Web Mapping module for direct download. The recent demonstration at WSSD of Open GIS compliant servers and interoperability illustrates the potential contributions to be made with servers in developing countries. The project also institutionalized a Center for Geographic Information (CIGEO), <http://www.cigeo.unitec.edu/> at a private university, *Universidad Tecnológica Centroamericana (UNITEC)* <http://www.unitec.edu/> to play a more active role in supporting national reconstruction and mitigation activities and develop an educational program for the region.

Successes and Challenges: Much progress has been achieved with active participation by most countries and exemplary development and leadership exhibited several places, notably El Salvador, Mexico, and Uruguay. Organizations have realized that the simple acts required for metadata construction, although often originally seen as onerous, have not only allowed them to participate in a global initiative, “it has also been worthwhile because it allowed us to organize our “own” data holdings.” Nevertheless, these early developments are only the beginnings of a much larger and more daunting task – the completion of NSDIs that have the potential for regional and global cooperation.

Let us briefly examine what worked well and what needs assistance:

- donor synergy** was very beneficial, indeed essential;
- integration of various expert consultants** was an asset;
- committed organizations and impassioned individuals** are important;
- funds for some infrastructure**, hardware and software are helpful;
- regional workshops** that develop “esprit de corps,” facilitate **personal networking**, and develop indigenous resources are crucial for sustainability;
- intimate collaboration** that goes beyond training is helpful;
- true participation in the international development** is positive;
- language** competencies, sensitivities, and instructional materials are important;
- initial support for “dedicated staff time”** is usually required;
- a “neutral” implementing agency** can be an asset for regional development;

- “cutting edge” developments** should be encouraged when possible;
- training the trainers** worked especially well;
- distributed responsibilities within an integrated regional project** is useful;
- regional, standards based approaches to the development of public services and goods **is efficient and sustainable**;

What will facilitate this regional approach to national development and involvement?

- an enhanced understanding at the ministerial level** of both the importance of public goods and of the value of geospatial data;
- institutionalized support for core data development and maintenance**;
- stronger linkages** between donor-supported land administration, disaster management, environmental and agricultural programs, so as to avoid duplication and provide combined financial support for the development of core data sets;
- good cooperation and coordination** among various national agencies and organizations;
- development and implementation of national spatial data infrastructures (NSDIs)**, both technical and institutional components;-consistent training and software upgrades;
- clear and enforced policies** of data access, distribution, and intellectual property rights;
- greater institutional stability** during changes in administration;
- donor support for the regional development** of consistent standards, spatial projections, geodetic controls, and protocols;
- sustained involvement of national practitioners** in effective regional planning;
- development of regionally recognized resources** – both material and personnel;
- an annual or biannual conference** or workshop should be initiated and supported;
- an effective regional organization that recognizes the value** of national involvement and national ownership and maintenance of data.

2.2. Remote Sensing, Consistent Land Cover/Use and Integrated Core Databases, and Internet Map Servers

The Caribbean region is a global priority for biodiversity conservation (McNeely et al., 1990) because of its high species richness and endemism, accelerating risk from land-use change, impacts of population expansion, rapid urbanization, coastal zone development, tourist impacts, natural disasters, and climate change. These impacts all require substantial land use planning to support immediate humanitarian concerns and longer-term sustainable development. This planning requires the development of core data sets and the integration of them in totally interoperable manners at national levels and with some consistency across the Basin. Again we have an opportunity to leverage various donor interests and to provide data and services efficiently and for the public good. Initial funding from the USAID will support the development of integrated databases and their implementation on national or regional Internet map servers (Figure 3). Awards to most island nations from the ESRI will provide extensive software and some training support. We require further support for national capacity building and integrated training to facilitate data development and full server implementation.

This work will be initiated by an on-going collaboration between the US Forest Service's International Institute for Tropical Forestry (IITF), the EROS Data Center (EDC), The Nature Conservancy's International Conservation Program (TNC), and national agencies and cooperators <http://edcintl.cr.usgs.gov/carlises.html>. We will develop a satellite image-derived and field-verified land cover/use basemap for the entire Caribbean as an essential core layer for this integrated database. A Caribbean-wide database will enable improved conservation; forestry, agricultural, and economic planning in the region; facilitate climate-change modeling; support commodity IMSs; and mitigate disasters. All Landsat 7 source imagery (at least two times coverage) has been rectified and is already provided as a public good for free download or purchase at a nominal price. The classification of land cover will be based on the U.S. National Vegetation Classification standard modified to include the vegetation of the Caribbean region (Areces-Mallea et al., 1990). The project will produce detailed raster products and more generalized vector coverages as well as ancillary data sets integrated into an interoperable IMS for each country.

Successes and Challenges: Projects of this type will be facilitated by:

- clearinghouses, and data access** needs described in 2.1;
- regional institution capacity** for sector specific data development/distribution remote sensing source data and products;
- donor coordination** of related project needs and deliverables;
- training funds** to broaden the impacted cooperators;
- workshops and conferences** to broaden the stakeholders and disseminate information;
- development of regional resource networks** to maintain and apply tools;
- regional support for consensus building** and diffusion to others;
- facilitated mechanism for access to remote sensing data;**
- national standards and interoperability.**

2.3. Prototype Development of Internet Accessible Parcel Certification Systems: Integration of Spatial and Information and Communication Technologies

Recent advances in ICT and in the applications of remotely sensed data now provide new opportunities for both marketing global commodities and providing assurances of product quality and identity as well as conservation and environmental management. At the core of an operational system is an **Internet Map Server** that makes detailed and georeferenced information and querying about parcels or commodities available to potential users via their browsers over the Internet. The producer or association can provide certifiable information to the users; the users can query the system and identify those attributes of interest and quantities of commodities available. These capabilities have now converged with other market forces and global developments that require an enhanced capability of commodity and parcel identification. This has been prompted by the globalization of trade, which has removed some removal of arbitrary support and protection; excess production of coffee with a substantial impact on developing country economies; opportunities to exploit niche markets and facilitate income for quality and

specialty products; concern for habitat and environmental preservation both within parcels and in adjacent natural areas (Masters and Abbott, 2000); appropriate labor practices; trace back opportunities for product assurance; implementation of fair trade practices;; etc. These diverse factors, the global nature of the location of producers, the predominance of exports from developing countries, the need for ready and transparent confirmation, and the monitoring of natural resource management and environmental protection require the integrated applications of tools provided by remote sensing, geographic information systems, and browser accessible web-based spatial information delivery systems.

A prototype for these “**internet accessible parcel certification systems,**” CarLISES (Caribbean Land Information System for Environmental Sustainability) was developed in support of the banana industry and conservation needs on Dominica. The prototype has been greatly expanded geographically and functionally. We will review the status of these systems, the data and resource requirements, and the potential functionality. Because of the demand for these approaches, we have incorporated our approach in a “Sustainable Tree Crops” program that consists of two parallel components: one in Latin America (Dominican Republic, Peru, Central American countries) and another in Africa. Commodities currently supported include: bananas, coffee, cocoa, and cashews. The overall goal of these projects is to:

“work cooperatively in a capacity building venture to secure the data for a group or organization of growers that will allow the development of web-based information systems to document the parcel management practices; the processing practices; the natural resource management approaches; the parcel history; the environmental, biodiversity, and ecological protection; appropriate environmental management; and, even, the potential role of carbon sequestration and climate change mitigation”

Although figure 4 illustrates the major elements of an IMS system, it should be clear that the role of the EDC is to provide the technical capability to establish the framework, to assist in land cover and associated monitoring, and to implement a complete and operational system. The need for diverse datasets for each application is illustrated in the presentation and identified in Annex 2. The maintenance of this system, and, in fact the core ingredient for success, marketing and public relations, remain with the association.

Dominica: The prototype CarLISES IMS now residing at the DBMC (now = Dominica Banana Producers, Ltd.), <http://www.dbmc-dm.com> supports the export of premium quality bananas and insures appropriate conservation practices. The Certified Farmer Program was developed to facilitate the expansion of a core of farmers/farms capable producing, processing, and packaging bananas to meet these specific requirements. A major component of CarLISES is a land-parcel certification system with user access via the Internet. Attributes include information on land ownership, land use, historical land management practices, crop management and rotation systems. The European retail outlets developed a series of criteria that must be met in order for the fruit to be certified. This includes geophysical aspects (soil type and depth, slope, altitude, rainfall, etc.) phyto-sanitary conditions (leaf spot control, proper packaging, and timing of harvest) as

well as plot, harvest and packing management practices. Parcel georeferenced practices supports an audit function and permits a consumer to query via the Internet about parcel location and certification. The prototype implements newly developed approaches to GPS parcel delineation, a thorough database of land use and growth management features, and on-line displays of banana parcels and their relationships to land cover and broad environmental concerns. The system allows users (consumers or importers in Europe) to access this information over the Internet with on-line data querying and mapping capabilities and can provide full “trace-back” capabilities to the consumer.

Peru: The system, <http://www.perucoffee.com> in Peru identifies coffee and allows a client to select specific attributes including: type, altitude of origin, shade grown, and others. A client can identify quantities of coffee meeting client-specified query criteria and determine availability from associations or growers.

Dominican Republic: In addition to the querying capabilities described by the two previous systems, this developing system, <http://www.dominicancoffee.com> illustrates the importance of conservation and biodiversity protection. Comparisons of Landsat imagery allows the client to examine the location of coffee farms relative to park and preserved area boundaries as well as to examine changes in forest cover, indicative of deforestation or reclamation efforts.

East Africa and West Africa: Although activities in East Africa (Ethiopia, Uganda, Kenya, Rwanda, and Tanzania) are only now starting, parallel activities illustrating an additional potential are provided by <http://www.africanlion.com>. This group is pioneering the on-line cupping competition with a direct auction of East African Fine Coffees. The first auctions have resulted in prices which substantially exceed current market prices and are intended to reward small holders for quality coffee and to reduce the transaction costs that have intervened between retail prices and grower returns. The current system provides a convenient mechanism to obtain assurance of product quality, to receive premium prices for quality coffee, to facilitate export clearance and credit authorization, and to facilitate delivery.

Although in many cases these systems are only now developing and are not fully implemented, the industry is changing. Greater attention is being paid to quality for the client and a fair return to the diligent farmer, standards for acceptable coffee are being considered, and new marketing mechanisms to insure access to niche markets are evolving. Although individual beans are more difficult to track than bunches of bananas, new chip technology can provide an inexpensive mechanism to support commodity custody during shipment and traceback capabilities to support source identification and appellation protection. Some of these approaches are now under development in the East Africa program. The BBC news release <http://news.bbc.co.uk/2/hi/business/2225803.stm> suggests a “plan to create an 'appellation' - a marque which guarantees coffees come from the best regions, with the best production methods and promise the best taste.”

Successes and Challenges: Early prototypes of “internet accessible parcel certification systems” suggest:

- the technology can handle** the data density, variety, and querying that is needed;
- extension systems** readily adapt to the new technology to collect necessary databases and secure georeferenced farm locations;
- the potential to assist market competitiveness** for quality commodities is recognized;
- client perceptions of web-based IMS systems are very positive**;
- the system provide exceptional marketing** and public relations opportunities;
- opportunities to facilitate export clearance** and on-line purchases are present;
- implemented systems can support other commodities**;
- excellent management tools** are provided by the data richness, data accessibility, and spatially explicit querying for associations and ministries;
- applications for conservation assessments** and environmental management are an obvious extension;

- bandwidths are often limited** in developing countries and internet service providers are often expensive because of limited competition;
- although growers associations or ag ministries may have robust databases** about valuable commodities, these are often not in a suitable format or have been adequately quality controlled;
- core data are often not yet available or of inadequate quality;
- detailed project level data** for farm level monitoring and georeferencing need to be developed;
- **specific training in spatial data development and internet querying and map serving** are greatly needed because the technology is still new;
- historical or institutionalized mechanisms** need to adapt to support these market innovations;
- data maintenance systems and quality assurance** are essential;
- remote sensing data on conservation areas are needed** to continually monitor good practices;

3. GASSIA Workshop Recommendations to Donors

<http://edcintl.cr.usgs.gov/gassia.html>)

The Geospatial Applications to Support Sustainable International Agriculture (GASSIA) workshop (funded by the USGS, USAID, Rockefeller Foundation, and the CGIAR Centers) brought over 65 geographic information science and technology professionals from 28 international organizations to facilitate cooperation among international organizations and to increase the efficiency and productive use of geospatial data. The solution proposed by the workshop participants included a “framework” or “infrastructure” consisting of core datasets, data standards, data policies, and demand-driven tools. In effect, these will help establish a functional information “backbone” for the research and development communities with relevance to all sectors. The report, accompanying this presentation, should be referenced for greater detail regarding additional recommendations from that group. The following suggestions are in response to an understanding of the central role that donors, and recipient countries, can play in

assuring that certain acceptable practices are maintained and endorsed thereby enhancing both the efficient use of resources and facilitating sustainable development.

Donor Cooperation

1. Establish an inter-donor working group to facilitate donor cooperation for the implementation of a global paradigm for geospatial development and applications.

Core Data and Clearinghouses

2a. A comprehensive needs assessment for core data should be carried out for the major developing world regions and at regional and national levels. Support the definition of core data sets, including standards, at various administrative levels, assess their availability in developing countries, and develop programs to support their development and maintenance.

2b. A task force with multi-donor funding should develop a strategy to evaluate the need for investments to achieve sustainability of national agency geographic information systems and other geospatial facilities. Efforts should be made to increase awareness in the donor community of the difficulty and cost for national agencies to establish and maintain a spatial data facility. Investments that require adherence to standards and interoperability could also help insure the availability of data even in times of insecurity.

Donor Requirements to Support the Public Goods Nature of Geospatial Data

3a. Project investments should be implemented within policies that emphasize data standards, best practices, data accessibility, and incorporation of OpenGIS protocols. At the onset, data standards must be incorporated into the project work plan, the relationships between data producers and data users (researchers and clients) must be clearly articulated, and provisions to include project results, data, and metadata in accessible and searchable forms must be specified

3b. Donors should require recipients to deposit their data with full metadata in a clearinghouse or other accessible location. This would be a condition of the award, just as scientific publications for research grants are expected. All funded projects should be geo-referenced to enable the creation of a database of agricultural and environmental development projects, including geographic information on field sites and areas of influence on each project. Both 3a and 3b are simple requirements that all projects should be asked to meet, and the donors are in a position to make this happen.

Capacity Building and Technology Transfer

4a. Investments should support innovative applications which are cost effective and apply cutting edge technologies, such as the newly advanced remote sensing tools, hand-held GIS for fieldwork, Internet map services, embedded chips for tracking, and global positioning systems. These investments and practices should be promoted even though the infrastructure and capacity are not necessarily present today. New developments hold the promise for developing countries to “leap frog” certain technological steps. Thus, the potential for true peer cooperation in the future is maintained and could become a reality.

4b. The international development community should encourage improved Internet access in developing countries.

4c. Activities to promote sustainable capacity building in developing countries should be increased. This support can be provided in ways that not only support sustainable development, but also directly encourage human networking and common practices on a global network. This should go well beyond training opportunities and workshops.

4d. Focus on the development of regional human resources and institutions of excellence which, however, maintain close ties with similar organizations in the developed world. Current opportunities in Central America and the Caribbean, e.g., to integrate the project needs of the USAID, the World Bank, and the IDB with the experience of the EDC and the support of ESRI exist and should be seized. These should emphasize the development of indigenous human capital that can serve as a continuing regional resource.

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Figure 1. Paradigm of Various Components in a Functional Global Data Infrastructure
Adapted from graphic by Doug Nebert, Global Spatial Data Infrastructure Secretariat, 2001.

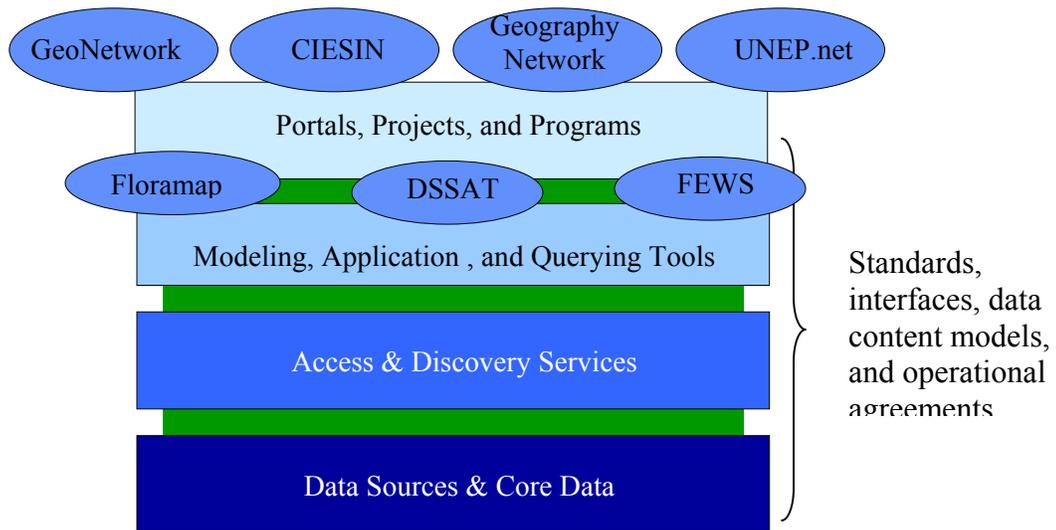


Figure 2. Location of registered Clearinghouse nodes in the Caribbean Basin.

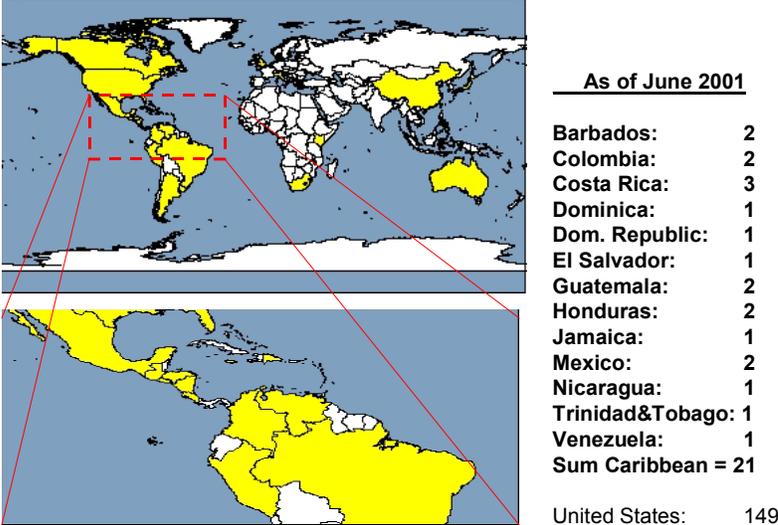


Figure 3. Development of an Adaptable Land Cover Database as a component of a national Internet Map Server.

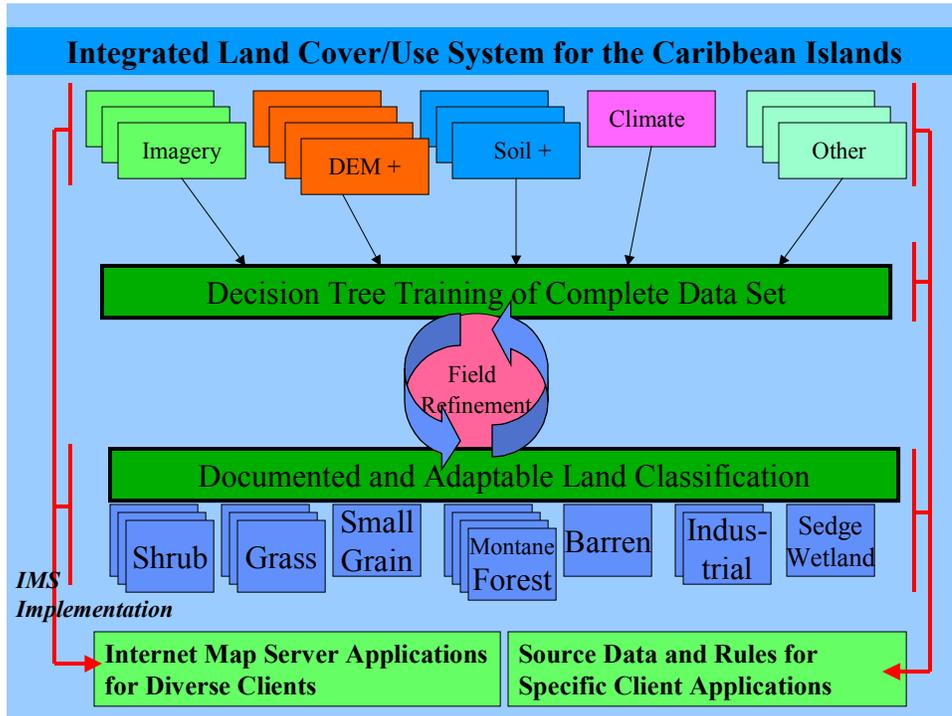
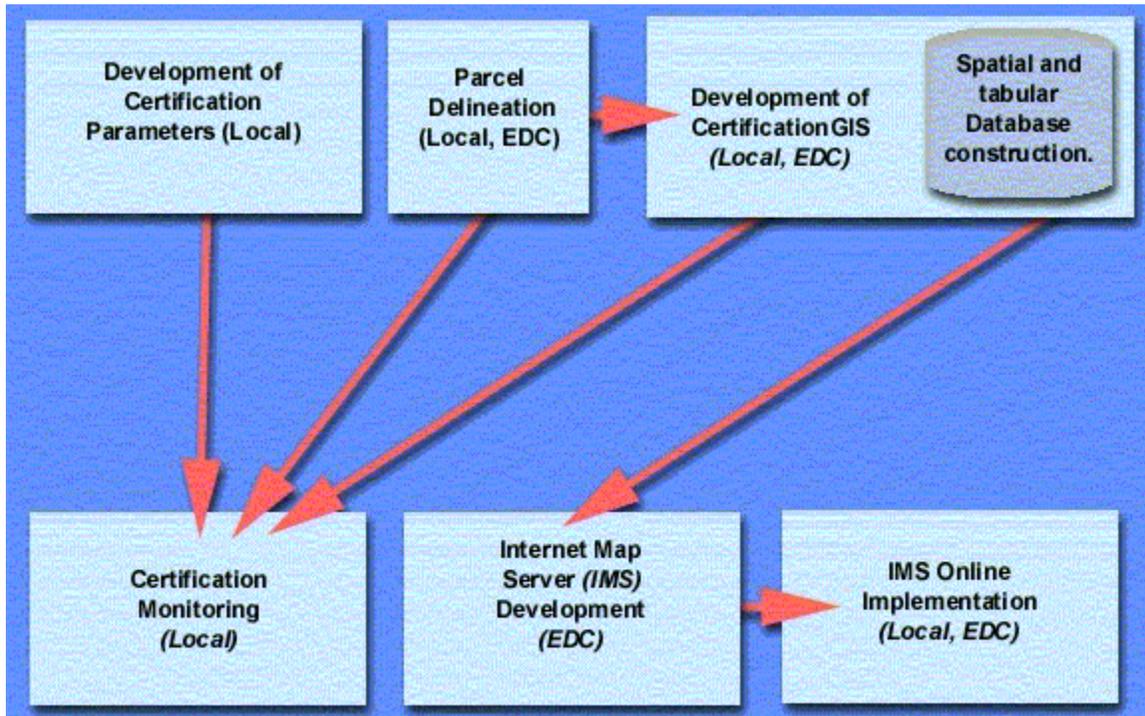


Figure 4. Steps, Major Activities and Responsibilities in Project Development.



Annex 1. Clearinghouses and Web Sites Developed through Mitch Support in an integrated regional approach in which organizations participated based on the appropriateness of their data holdings and their technological infrastructure in each country:

Honduras

Universidad Tecnológica Centroamericana (UNITEC) <http://www.cigeo.unitec.edu>

Instituto Geográfico Nacional (IGN):

Secretaria de Recursos Naturales y Ambiente (SERNA): <http://www.serna.unitec.edu/>

Secretaria Técnica y de Cooperación Internacional (SETCO)

Fundacion para el Desarrollo Municipal (FUNDEMUN)

Servicio Autonomo Nacional de Agua y Alcantarillado (SANAA)

Secretaria de Agricultura y Ganaderia (SAG)

Nicaragua

Ministerio Agropecuario y Forestal (MAG-FOR) <http://www.magfor.gob.ni/>

Instituto Nicaraguense de Estudios Territoriales (INETER) <http://www.ineter.gob.ni/>

Ministerio de Recursos Naturales (MARENA) <http://www.marena.gob.ni/>

Foundation Alistar: <http://www.alistar.org.ni/>

El Salvador

Instituto Geografico Nacional (IGN): <http://www.cnr.gob.sv/ign/ign2000.htm>

Ministerio de Medio Ambiente y Recursos Naturales (MARN) <http://www.marn.gob.sv/>

Ministerio de Agricultura y Ganaderia (MAG) <http://www.mag.gob.sv/>

El Viceministerio de Vivienda y Desarrollo Urbano: <http://www.vmvdu.gob.sv/>

Oficina de Planeación del Area Metropolitana de San Salvador:

<http://www.opamss.org.sv/>

Guatemala

Secretaria de Planificacion y Programación (SEGEPLAN) <http://www.segeplan.gob.gt/>

Instituto Geografico Nacional (IGN): <http://www.ign.gob.gt/>

Comision Nacional del Medio Ambiente (CONAMA):

<http://www.conama.gob.gt/acerca/acerca.html>

Comision Nacional para la Reduccion de Desastres (CONRED): <http://www.conred.org/>

Instituto Nacional de Sismología, Vulcanología, Metereología e Hidrología

(INSIVUMEH)

Universidad del Valle <http://www.uvg.edu.gt/>

Dominican Republic

Dirección General de Ordamiento Territorial (DIGEORTE):

<http://www.cad.org.do/digeorte.html>

Instituto Nacional de Recursos Hidráulicos (INDRHI): <http://www.indrhi.gov.do/>

Instituto Cartográfico Militar (ICM): <http://www.icm.mil.do/>

Instituto Geográfico Universitario (IGU)

Regional Agencies:

Convenio Constitucional del Centro de Coordinacion para la Prevencion de Desastres Naturales America Latina (CEPREDENAC) <http://www.cepredenac.org/>

Comision Centroamericana de Ambiente y Desarrollo (CCAD): <http://ccad.sgsica.org/>

Centro Agronomico Tropical de Investigacion y Ensenanza (CATIE; Costa Rica)

<http://www.catie.ac.cr>

Annex 2. Core Data and Ancillary Spatial Datasets Required for Sustainable Tree Crops Program.

Spatial data requirements for the STCP are extensive, necessary at multiple scales, and derived from multiple sources where possible. At the continental or regional (e.g., West Africa and East Africa) levels these datasets are typically derived from the DCW, FEWS/ADDS, FAO, USGS, IGBP-Dis, and the EarthSAT mosaic. Specific donor-funded regional projects are also often valuable sources (e.g. USAID-funded CARPE, University of Maryland) for land cover, soils, administrative boundaries, hydrography, DEM, and Landsat coverage. At national and project levels, dataset availability is more problematic and comes from a wide variety of ministries (e.g., Agriculture, Environment, Lands and Surveys), donor projects, and NGOs.

Appropriate data are often difficult to locate unless they have been published and/or deposited with metadata in Clearinghouses, not yet well developed in Africa. When available, they are often of insufficient spatial and temporal resolution. Often several thematic layers, e.g. soils, land cover, are missing; and usually time series of satellite data have not been acquired, purchased, or processed. These difficulties are further compounded by lack of standardization, uncertain quality control, and incomplete national coverage. Francophone countries due to the presence of ORSTOM often have soils coverages far exceeding what might be expected for other African countries of similar economic status.

Most STCP national studies lack appropriate DEMs, soils coverages of sufficient resolution or national extent, and land cover that is accurate or up to date. There are certainly exceptions. In Uganda, the National Biomass Study created a comprehensive digital dataset based upon the national topographic mapsheets and forest/land cover inventories conducted during the study. This resulted in a land cover product, functional high resolution DEM, and other useful ancillary data. These and other data are available at a fairly high price thereby limiting their public availability.

Example of data sets, arranged by source, required by STCP:

DCW data sets (scale 1:1,000,000)

1. Cities to Village Locations (Populated Places)
2. Transportation Routes (Railroads, Roads)
3. National Political Boundaries

ADDS Server:

1. Sub national boundaries (scale varies).
2. NDVI (Normalized Difference Vegetation Index) (Res. 8km).
3. RFE (Rainfall Estimate) (Res. 8km).

USGS:

1. Gtopo30 DEM (Res. ~1km)
2. Hydro1k
3. Global Land Cover Characterization (GLCC) (Res. 1km)
4. Global Forest Resources Assessment (FRA 2000) (Res. 1km)

EarthSAT®:

1. TM Mosaic of Africa (1km)

World Bank:

1. African Development Indicators Database. (Tabular)

CARPE

1. Terrestrial Ecoregions (Developed by WWF)
2. National Parks and Protected Area of Cameroon.

National data sets:

Cameroon's Ministry of Environment and Forests (MINEF) scale 1:200,000:

1. Transportation.
2. Hydrology
3. Vegetation Classes.
4. Sub National Boundaries (not complete)

University of Maryland.

1. Landsat 5, 7 scenes

Uganda's National Biomass Study (scale 1:50,000):

1. Contours (Final product was DEM).
2. Sub National Boundaries.
3. Hydrology.
4. Land Use/ Land Cover Classification.
5. Transportation.
6. Protected Areas

Project level data sets:

Required data sets:

1. Farmer cooperative extents (boundaries).
2. Farmer parcel delineations.
3. Collection and maintenance of attributes for spatial data.

Additional and ideal spatial data sets:

1. High-resolution digital elevation model (DEM).
2. Large scale soil classes, greater than 1:1M.
3. Sub-National Land use classification (current and/or historical)
4. High-resolution imagery.
5. Spatial defined precipitation data.