Survey of the Development of National Spatial Data Infrastructures in Latin America and the Caribbean

Glenn Hyman and Claudia Perea
International Center for Tropical Agriculture

Dora Ines Rey
Agustin Codazzi Geographic Institute

Kate Lance
United States Geological Survey/EROS Data Center and Global Spatial Data Infrastructure Secretariat

Abstract

Change detection is a common routine by the GIS community, but typically for monitoring deforestation or increased crop productivity. This paper attempts to detect change in spatial data infrastructure development in Latin America and the Caribbean. The International Center for Tropical Agriculture (CIAT) and the Agustin Codazzi Geographic Institute (IGAC) are working with the Global Spatial Data Infrastructure (GSDI) initiative to survey progress in the development of national spatial data infrastructures (NSDI) in Latin America and the Caribbean. A GSDI global survey was translated to Spanish and posted on the web. The survey asks respondents about all aspects of NSDI, including leadership of SDI initiatives, legal and policy frameworks, fundamental data development and main challenges for the future. Multiple replies for the same country were merged into a single response. The survey was first published in March 2000. In early 2003, the survey information was updated for some countries in Latin America and the Caribbean. The survey results show that countries that have some identifiable problems requiring the integrated use of spatial data across agencies and disciplines, realized the need for NSDI and have made important progress. However, in many countries, the adoption of NSDI has been slow or absent. The most important factors affecting adoption of NSDI in the region are awareness of SDI concepts and technology, level of political will of decision-makers and officials throughout key organizations to implement these systems, and resources that are dedicated to spatial data development and sharing of information.

Acknowledgments

Introduction

Growing interest in geographic information for sustainable development has led many countries and organizations to adopt a combination of technical, policy and organizational mechanisms for sharing spatial data across networks. These mechanisms are known as spatial data infrastructures (SDI). They advance the capacity of countries, local governments and organizations to share spatial information and knowledge across distributed networks. SDI have been adopted to varying degrees throughout the world (Borrero 2002). Latin America and the Caribbean is no exception, with most countries having made efforts to put in place at least some elements of SDI. However, a collective vision of distributed geographic information systems for research and development requires widespread adoption, something that has not yet occurred in Latin America and the Caribbean.

Our understanding of the adoption of SDI technical and policy mechanisms could guide future investments in networked geographic information systems (GIS). Understanding lessons learned in the adoption of national spatial data infrastructures (NSDI) throughout the region could be useful to those looking for ways to promote their efforts. However, we lack basic information about the development of NSDI's or the impact they have on research and development, and on decision-making. How has NSDI been adopted over time in Latin American and Caribbean countries? Is NSDI development on the rise or has it dwindled?

We reviewed responses to a GSDI survey carried out in 2000 (Lance and Hyman 2001). Updates to the GSDI survey were collected in 2003 for a subset of Latin American and Caribbean countries. We gathered public domain information to analyze the extent to which Latin American and Caribbean countries are adopting NSDI concepts and increasing their participation in networked GIS. The extent to which Latin America and the Caribbean countries will adopt NSDI in a comprehensive way remains unclear.

Methods

Our involvement in the Central American Geographic Information Project (PROCIG) motivated us to investigate the development of NSDI in Latin America (Hyman et al. 2001). Our NSDI research has been partly based on the survey developed by Harlan Onsrud for the Global Spatial Data Infrastructure (GSDI) initiative (Onsrud 2001). The GSDI survey covers most aspects of NSDI, including organizational and legal issues, data access mechanisms, prices for data, technical aspects of metadata and clearinghouse search mechanisms, and questions about fundamental data resources for a country. We translated the GSDI survey to Spanish and sent it to Latin America and Caribbean countries in 2000. In February 2000, 24 respondents returned completed questionnaires for 18 countries in the region.

The results of the initial survey, acquired in the year 2000, were presented at international conferences on spatial data infrastructures (Hyman and Lance 2000, Lance and Hyman 2001). In this paper, we review some of those results. Readers will find the GSDI survey results on the PROCIG web page (PROCIG 2001) and on the Harlan Onsrud's web page (Onsrud 2001).

In early 2003, we asked the respondents of the 2000 GSDI survey to send us an updated questionnaire response, including changes in NSDI initiatives since the original survey. We received replies for the following nine countries:

- Brazil
- Chile
- Colombia
- Cuba
- Ecuador
- El Salvador
- Mexico
- Panama
- Venezuela

We analyzed the changes that occurred in these nine countries in the three years that have passed since the original survey.

The GSDI questionnaire responses are "snap shots" of the status of NSDI in a country. They are the observations of one person who filled out the questionnaire, when in fact there are almost certainly varying views of NSDI status.

We also acquired the dates of registration for Latin American and Caribbean spatial data clearinghouse nodes from the Federal Geographic Data Committee's (FGDC) Registry. The development of these clearinghouse nodes over time could help us to understand whether it is likely that this technology will be developed further in the future, or whether adoption has stalled.

For the purposes of this review, we are using clearinghouse development to gain insights on NSDI adoption. Clearinghouse development is just one indicator of NSDI adoption. A country may have made efforts in advancing NSDI, though they lack a clearinghouse node. Alternatively, they may have a node, but remain deficient in other components of NSDI. We recognize that there are many other aspects to SDI development, and that clearinghouses are just one aspect of SDI.

We also briefly reviewed conference papers and institutional web sites to get a sense of developments in the region. Links to many of these resources can be found on the GSDI (2003) and PROCIG (2001) web sites.

Results and Discussion

Review of the 2000 GSDI Survey for Latin America and the Caribbean

Almost all Latin American and Caribbean respondents to the initial year-2000 GSDI survey said their country had some kind of effort or proposal to develop a national spatial data infrastructure (Lance and Hyman 2001). National mapping agencies led NSDI initiatives in eight countries in the region. Ministries of Environment directed three NSDI initiatives. Combined geography and statistics institutes led two of the initiatives (Mexico and Brazil). Most of the NSDI initiatives are multi-institutional, though some countries have strong leadership solely from the national mapping agency. The median number of institutions involved in NSDI in a Latin American and Caribbean country was five, though Chile had 23 institutions involved in the initiative

in the year 2000.

Survey respondents were asked to list the most important data needed for the NSDI in their country (Table 1). Topographic, transportation, land use and land cover, political divisions and hydrography were considered the most important fundamental data resources needed for NSDI.

Table 1. Fundmental Data for Latin American and Caribbean Countries

Type of data reported as being fundamental to the NSDI Initiative	Number of Responses
Topographic Maps	14
Transportation Maps	12
Land Use and Land Cover	12
Political Divisions	11
Hyrography	11
Soils	10
Geology	9
Census Data	9
Catastral / Land Administation Data	8
Forestry Surveys	8

According to the 2000 GSDI survey, only a few Latin American and Caribbean countries have laws that support the development of NSDI's. But most countries of the region have no law, government directive or other legal mechanism that calls for the development of NSDI. Few countries in the region have well-established policies for data dissemination and sharing of information. In most cases, anyone who needs government data must contact each individual agency that holds the data. Usually, institutions have standard data sets that are available for purchase in paper or digital formats. Often, these data sets do not include spatial data because geographic information is relatively new to many agencies.

Survey respondents were asked to identify the major challenges that they faced in order to make NSDI a reality in their country. Respondents identified the lack of financial resources as a fundamental constraint to NSDI development. Respondents cited legal matters, copyright and intellectual property rights in general as important issues that must be faced if these initiatives are to succeed. Respondents said that standards for geographic data and policies for data access and dissemination need to be developed in their countries. Other challenges include developing on-line services, making available and producing fundamental data, creating and sharing metadata and securing high-level commitment from agency directors.

Overall, the 2000 GSDI survey for Latin America and the Caribbean showed good progress toward achieving NSDI in several countries. But for most of the region, these initiatives had yet to become part of the agenda of directors and decision-makers of the leading government agencies that would implement NSDI.

Recent NSDI Developments in Latin America and the Caribbean: 2000 to 2003

NSDI concepts became widely known in Latin America and the Caribbean in the 1990's. According to the 2000 GSDI survey, NSDI concepts had clearly become a topic of interest among the community of professionals interested in launching national networks for geographic data discovery, sharing, and development. But what occurred in the way of advances in development and implementation since 2000? Below, we describe recent developments for nine countries that sent us an updated survey.

The 2003 Brazil GSDI survey indicates that more organizations are participating in the NSDI and that funding is being dedicated to SDI activities. The Brazilian Institute of Geography and Statistics (IBGE) has launched map servers showing environment and demographic information (IBGE 2003). The Ministry of Budget Planning and Management leads the Brazilian NSDI, with strong participation of IBGE and the National Institute of Space Research (INPE).

Of the nine countries that provided an updated GSDI survey response, Chile has made the most significant advances over the last three years. Much of their success appears to be related to the development of the National Territorial Information System, developed by several different government agencies. Chile established a clearinghouse node in early 2001, which currently holds metadata for over 1,100 digital maps (Instituto Geografico Militar 2003). Whereas the Chilean NSDI in the year 2000 included broad participation (23 institutions), the initiative now appears to be the effort of several key government agencies. The Chilean NSDI now has dedicated funding for NSDI research within government agencies, better definition of pricing policies for data, plans for participation of the private sector and a long-term strategic vision. The presidential directive that established the National Territorial Information System is perhaps the most significant success factor moving forward Chile's NSDI (Gobierno de Chile 2001).

The Agustin Codazzi Geographic Institute (IGAC) and other government agencies established Colombia as an early adopter and developer of NSDI. A core group of Colombian institutions have signed agreements on how the NSDI will work, have developed NSDI working groups and have held meetings to advance their network. The result is the Colombian Spatial Data Infrastructure (2003). IGAC will soon make a web site publicly available so that users can search their spatial data clearinghouse node. Since 2000, Colombia has made significant advances in the development of national standards for metadata, geospatial positioning, geodetic networks, data precision, navigation charts, and quality of geographic information. Recently, IGAC launched a new metadata management system that includes over 100,000 records. The system will be made available on the Internet in July 2003. These developments are the result of dedicated personnel and funding for NSDI activities. Clearly, much of Colombia's success with NSDI development is related to their strong participation in the Global Spatial Data Infrastructure (GSDI), the Global Map project, the Permanent Committee on Spatial Data Infrastructures for the Americas (CP-IDEA) and the Panamerican Geography and History Institute (PAIGH).

Although lacking a formal proposal to develop NSDI in 2000, Cuba made significant progress over the last three years in bringing the need for an initiative to the attention of important officials in the government. A proposal to issue a government decree establishing the Cuba NSDI is under review by the appropriate authorities.

The proposal would establish a "National Geographic Data Council." The National Hydrography and Geodesy Office leads the Cuban NSDI effort, with support coming from different government ministries. Cuban professionals working on the NSDI are making efforts to incorporate international standards into their overall initiative - including OpenGIS and ISO TC 211 geographic information standards, the Z39.50 clearinghouse standard and XML. Cuba has elaborated a study on the creation of the NSDI and they are now ready to move from planning to implementation.

The *Instituto Geografico Militar* (IGM) continues to lead Ecuador's NSDI efforts. According to their updated GSDI survey, they are promoting clearinghouse activities, greater participation of the private and non-governmental sectors, and the incorporation of international standards into their geographic information initiatives. An important advance for Ecuador is the development of a strategy and vision for the NSDI (Salazar Martinez 2003).

Under the United States Geological Survey's (USGS) Mitch Clearinghouse project, El Salvador registered a spatial data clearinghouse node in the FGDC registry in August 2001. It now has 435 metadata records, mostly for analog maps. While in the 2000 GSDI survey the private sector was considered to have a role in the NSDI, it turns out that they have not participated. According to the 2003 GSDI survey, El Salvador modeled their development of standards on work done by the Colombian Spatial Data Infrastructure. Given the advanced state of development of NSDI in Colombia, they could be a model for other countries as well.

Mexico's NSDI initiative is called the "*Infraestructura de Datos Espaciales de México*" or IDEMEX (Hansen Albites 2002). The Mexican NSDI is led by the National Institute of Geography, Statistics and Informatics (INEGI). Mexican government agencies, at the highest levels, have agreed to develop the NSDI and have dedicated funding to coordinate activities. The INEGI spatial data clearinghouse node holds over 8,000 metadata records. In early 2003, the Environment and Natural Resources Secretariat (SEMARNAT) established Mexico's second spatial data clearinghouse node, holding 525 metadata records. IDEMEX will be a part of INEGI institutional development plan to 2025.

Panama's updated survey for 2003 shows a more complete list of geographic data available to the public. But Panama has made only slight progress in advancing the organizational and policy elements needed to support NSDI. They still lack a government directive or mechanism for coordinated development of spatial information.

Venezuela began work to establish the NSDI back in 1996. The *Instituto Geografico de Venezuela Simon Bolivar* (IGVSB) established a clearinghouse node in 2002, and updated it to include 7,700 metadata records. Progress in other areas of NSDI development has been held back by the lack of funding for the geographic institute and changes in the government.

## Development of Spatial Data Clearinghouses in Latin America and the Caribbean

Data search and discovery mechanisms, usually referred to as clearinghouses, are key components of spatial data infrastructures. They help to satisfy the objective of data sharing across networks. If geographic information users are unable to find out

what data exists and how to acquire it, they cannot easily take advantage of other SDI components. Therefore, in many ways, the development of clearinghouses indicate how well SDI's are progressing overall.

We analyzed the clearinghouses registered with the FGDC. These efforts have the advantage of using standard protocols like the Z39.50 clearinghouse standard. Geographic information users could also search and discover data through standard Internet search engines. We expect that the ease of finding geographic information on the Internet through a search engine like Google or HotBot has increased significantly, partly because of increased use of the web in Latin America and the Caribbean. Future studies could attempt to account for geographic data discover on general Internet search engines.

Figure 1. Establishment of clearinghouse nodes in the FGDC Registry: 1999 to 2003
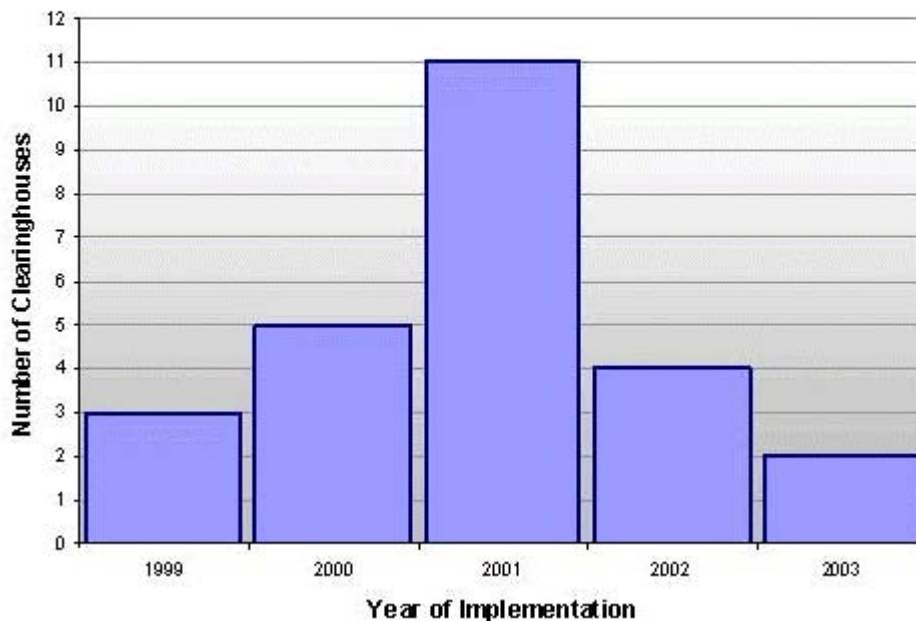
The FGDC registers 34 clearinghouse nodes for Latin America and the Caribbean data providers. In order to focus fully on the region, we excluded data providers holding global data that happens to cover Latin America and the Caribbean. For example, the World Conservation and Monitoring Center serves maps of protected areas for the entire world. We were unable to find the registration date for nine clearinghouse nodes in Latin America and the Caribbean.

Figure 1 shows that the first development of clearinghouses for the region occurred in 1999 when three nodes were established. Mississippi State University established the first node, actually for geographic data on the Gulf of Mexico. The USGS established the second node at Eros Data Center in Sioux Falls, SD to provide geographic data in the wake of Hurricane Mitch in Central America. Uruguay established the first node actually hosted in a Latin American or Caribbean country in

late 1999.

Five nodes were established in 2000, all in Mesoamerica. A node was established by the government of Dominica to provide geospatial data for the island nation. At Eros Data Center, a node was established to provide geographic information for the Caribbean. In Costa Rica, two nodes were established in 2000, both at Tropical Agronomy Center for Research and Training (CATIE) in Turrialba. However, one of these nodes serves the National Geographic Institute (IGN) of Costa Rica. The IGN node was established in CATIE to take advantage of their computing resources. Honduras established a fifth node in late 2000 at the Technological University in Tegucigalpa.

The FGDC registry records the establishment of 11 Latin American and Caribbean clearinghouse nodes in 2001. However, El Salvador appears to have a duplicate node registered with the FGDC. In South America, Brazil, Chile and Colombia established nodes in 2001. A node for Bolivia was set up as well, though this one was hosted at the Eros Data Center in Sioux Falls, SD. Four Central American countries - Nicaragua, Honduras, El Salvador and Guatemala - established clearinghouse nodes in 2001 as part of the Mitch Clearinghouse project led by USGS. A 2001 clearinghouse node was established for the Dominican Republic, but was hosted at Eros Data Center.

In 2002, four clearinghouse nodes were established - at the International Center for Tropical Agriculture (CIAT) in Colombia, the *Universidad Valle* in Guatemala, the *Instituto Geografico De Venezuela Simon Bolivar* and at Eros Data Center.

Through the middle of June of 2003, two clearinghouse nodes have been recorded in the FGDC registry. Mexico's Environment and Natural Resources Secretariat (SEMARNAT) set up a node in February. Eros Data Center established a node for geographic information on volcanoes for Nicaragua and the rest of Central America.

Figure 1 seems to indicate the growth of clearinghouse node establishment in 1999 and 2000, peaking in 2001. The number of new nodes drops off in 2002. Six months into 2003, the graphic appears to show a continued downward trend in the establishment of new nodes. However, this graphic could be misleading for several reasons. The peak that occurred in 2001 is largely due to the ending of the Mitch Clearinghouse Project in Central America, when these nodes went on-line. The node establishment dates for nine clearinghouses were unavailable, further complicating the interpretation of the graph.

The USGS and FGDC have played critical roles in NSDI technology transfer in Latin America and the Caribbean. 15 of the 34 Latin America and Caribbean clearinghouses are hosted on USGS or FGDC web sites in the United States. Many of these clearinghouse nodes would not have been developed without the technical and financial resources provided by the United States. The extent to which these clearinghouses can be sustained by the organizations in the countries where they have been developed is unclear. Officials in FGDC and USGS need to closely monitor these technology transfer efforts in order to ensure sustainability of the programs by national organizations. Continued technology transfer efforts by the United States will likely be an important factor in future clearinghouse adoption.

Figure 2 shows a map of the location of the host server for the 34 Latin American and Caribbean clearinghouse nodes. If there had been some kind of strategy to transfer clearinghouse technology to the less developed countries first, guessing that

the more developed countries would see the benefit and do it on their own - we could perhaps say that it would have worked. Adoption of clearinghouse technology in Central America and the Caribbean has largely been the result of technology transfer efforts by the United States. In general the more developed countries of South America, plus Mexico, appear to adopt clearinghouse technology on their own initiative. Ecuador and Cuba, two medium-sized countries without clearinghouse technology, are planning to set up nodes in the near future.

Figure 2. Active Clearinghouse Nodes for Latin America and the Caribbean.
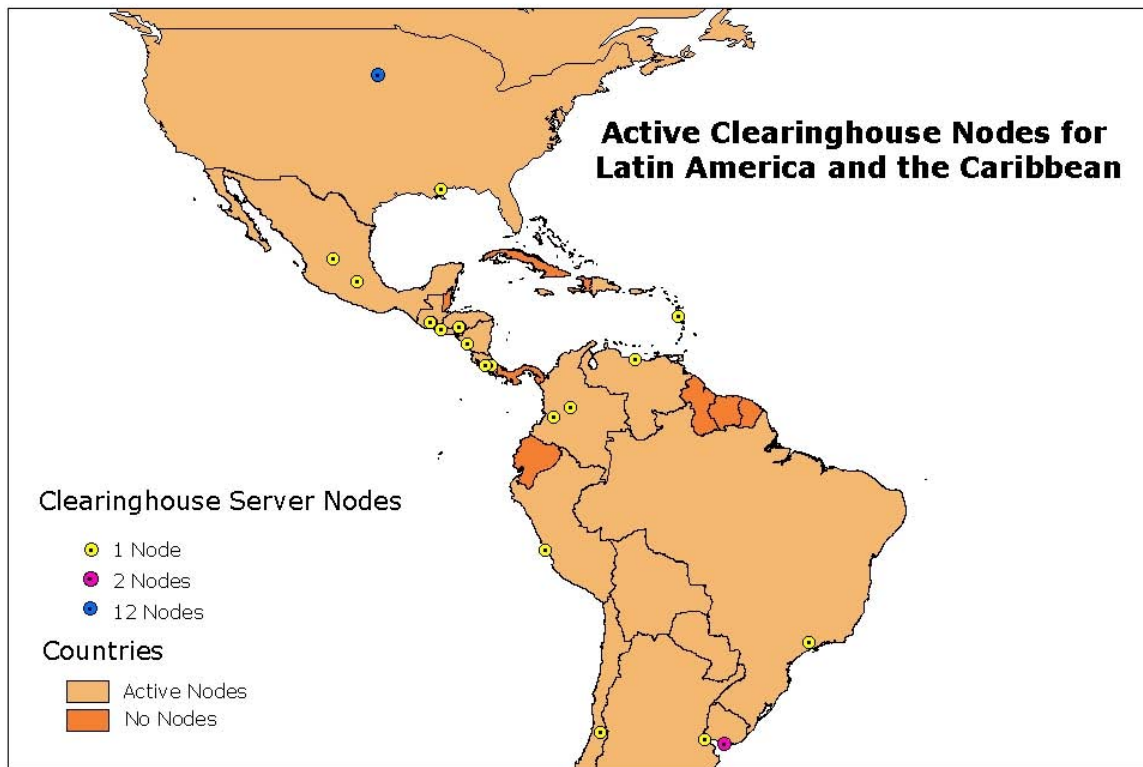
The lack of clearinghouse nodes in Belize, Haiti, the Guyanas and some of the small Caribbean islands is probably due to the size of these countries and their overall level of development of geographic information systems in general. Panama is an exception, given their otherwise solid development of GIS and participation in international initiatives.

Of the clearinghouse nodes hosted in Latin American and Caribbean countries, 10 of them are in the national mapping agencies, where we might expect establishment of new nodes in the countries that do not already have them. One of Mexico's nodes is hosted by the institution that combines mapping, statistics and information functions. Two nodes (CIAT and CATIE) are hosted by international agricultural research and development centers. Since the International Maize and Wheat Improvement Center (CIMMYT) and the International Potato Center (CIP) also have significant geographic data holdings, we might expect new nodes from these centers. Another two nodes are connected to major national universities in Guatemala and Honduras. Universities in the region could be a source for future growth as well. Two other nodes are within the environment ministry of their country.   In many countries of the region, environment ministries have the most advanced geographic information activities of all the organizations. They may be expected to be a source

for future growth of clearinghouse nodes.

GIS software providers are developing clearinghouse tools to help data providers let their clients know about their data holdings. According to some, these tools could help to increase the development of clearinghouse nodes since they could make it easier for data providers to set up map and metadata servers within the context of their geographic data management systems (Nebert 2003).

Although the development of spatial data clearinghouses is important, a more relevant question is whether a user can find and acquire the data they need. Most of the metadata records in Latin American and Caribbean clearinghouses only give the contact information of the data provider, information that only takes us a step closer to fulfilling the purpose of clearinghouses. Users need to be able to quickly download data from the Internet or access order forms to automatically request data. Furthermore, the user community needs to take advantage of the clearinghouse mechanism. Our sense is that many potential users are unaware that the clearinghouse exists. Those who are developing clearinghouse nodes need to put more emphasis on outreach to the user community.

Conclusion

The GSDI surveys suggest that Latin American and Caribbean professionals working with geographic information are aware of the utility of spatial data infrastructures and are making efforts to implement them. The updated 2003 survey responses for the nine countries reported in this paper show that progress is being made. In those countries where we lack updated information on recent progress, we expect that some advances are being made. Since our analysis focused on efforts at national levels, we are surely overlooking developments at local scales. For example, Honduran and Colombian municipalities have established efforts to develop local-scale GIS that work within SDI frameworks (Sistema de Informacion Regional 2003, USGS 2003).

No clear trend in NSDI adoption is evident in the evolution of clearinghouse nodes in the region. Many national mapping agencies have implemented clearinghouses, but there has been less adoption by environment, agriculture ministries, statistics and census agencies, or universities. Even less clear is whether non-governmental and private sector organizations will develop clearinghouse technology. Adoption of clearinghouse nodes is being driven by both "top-down" technology transfer efforts, and "bottom-up" demand for the technology. Because the sustainability of these initiatives will likely depend on real needs in the countries that implement NSDI, more effort is needed to understand the adoption process in countries like Uruguay, Chile and Mexico, where professionals and organizations applied clearinghouse technology largely on their own initiative.

Although we did not examine the management of clearinghouses, Crompvoets (2002) noted that the frequency of node updates is on the decline. Maintenance of the nodes in Latin America and the Caribbean is a concern, especially for those clearinghouses that received strong external support to set up the node at the outset of the initiative.

Several different scenarios could play themselves out with respect to NSDI

development in Latin America and Caribbean. These initiatives could lose momentum. Countries may decide to ignore SDI policy and institutional development, geographic information standards, metadata development, maintenance of their clearinghouse nodes and other components of NSDI. However, this scenario is unlikely since there appears to be widespread recognition of the utility of NSDI. Perhaps a more likely outcome - and similar to current developments in the region - is a diverse and mixed adoption of NSDI, with some countries making important advances while others are unable to progress. A third scenario for the future of NSDI in the region would be widespread adoption, which could occur if technology investments, capacity-building and innovations are combined with organizational efforts to make it work.

We recognize that NSDI adoption and development takes considerable time. The continued efforts of the Permanent Committee on Spatial Data Infrastructures for the Americas, the GSDI Association, the Panamerican Institute of Geography and History and others to raise awareness of the utility of SDI will be vital for further development of these initiatives. Capacity-building in national and local government agencies will likely be an important factor in further NSDI adoption.

More impact research is needed. SDI advocates need the 'ammunition' to demonstrate to high-level decision-makers the benefits of NSDI. How much can be saved by greater efficiency in the management of public sector data, by applying spatial analysis to planning, by avoiding duplication of effort, etc.? To what extent does spatial information improve decision-making and good governance? Without the proper economic and social arguments for SDI, decision-makers cannot be expected to prioritize SDI activities in their countries.

Unfortunately, we could not fully answer our question about whether NSDI adoption is increasing or whether it has leveled off in Latin America and the Caribbean. The developments we have documented in this paper are encouraging, but more study is needed. Further research should acquire the GSDI surveys for all the countries in the region. The development of spatial data clearinghouses is only one indicator of NSDI adoption. Other indicators are needed. A simple but robust mechanism to monitor SDI progress over time should be advanced, building upon the survey efforts from 2000 and 2003.

References

Borrero, Santiago. 2002. Cooperation, coordination and integration amongst global and regional SDI initiatives (case study). Budapest: GSDI 6 Conference - From Global To Local. 18th September 2002.

Crompvoets, J. W. H. C. 2002. Global developments of national spatial data clearinghouses. Budapest: GSDI 6 Conference - From Global To Local. 18th September 2002.

Gobierno de Chile. 2001. Instructivo Presidencial No. 14. Available from: http://www.snit.gob.cl/presentacion_instructivo_n14.htm. [Accessed 26 June 2003].

GSDI. 2003. Global Spatial Data Infrastructure. Available from: http://www.gsdi.org. [Accessed 15 June 2003].

Hansen Albites, Francisco. 2002. Towards the Mexican national spatial data infrastructure. Budapest: GSDI 6 Conference - From Global To Local. 18th September 2002.

Hyman, Glenn and Kate Lance. 2000. Encuesta sobre infraestructuras nacionales de datos espaciales en las Americas. Presentation at the International Seminar "Infraestructuras nacionales de datos espaciales", 28-29 Feb, Bogota, Colombia.

Hyman, Glenn, Kate Lance, German Lema and Claudia Perea. 2001. The Central American Geographic Information Project (PROCIG). Final Report to the InfoDev Program. July 16th, 2001. http://www.procig.org/downloads/procig-final-report-jul-16-2001-ingles.pdf.

Infraestructura Colombiana de Datos Espaciales. 2003. Infraestructura Colombiana de Datos Espaciales. Available from http://www.icde.org.co. [Accessed 26 June 2003].

Instituto Brasileiro de Geografia e Estadística. 2003. Instituto Brasileiro de Geografia e Estadística. Available from: http://www.ibge.gov.br/. [Accessed 26 June 2003].

Instituto Geografico Militar. 2003. Instituto Geografico Militar. Available from: http://www.igm.cl. [Accessed 26 June 2003].

Lance K, and Glenn Hyman. 2000. Spatial data infrastructures in Latin America: Implications for digital mapping at the regional scale. Paper presented at Workshop on Gridding Population Data, 2-3 May 2000, Columbia University, NY.

Lance, Kate and Glenn Hyman. 2001. Adoption and implementation of national spatial data infrastructure in Latin America and the Caribbean. Oral presentation at the 5th International Conference on Global Spatial Data Infrastructures. Cartagena, Colombia, May 2001.

Nebert, Doug. (ddnebert@fgdc.gov) 30 April 2003. Re: Yes! Email to Glenn Hyman (g.hyman@cgiar.org).

Onsrud, Harlan. 2001. Survey of national and regional spatial data infrastructure activities around the globe. Available from: <http://www.spatial.maine.edu/~onsrud/GSDI.htm>. [Accessed 15 June 2003].

PROCIG. 2001. Proyecto Centroamericano de Informacion Geografica. Available from: http://www.procig.org. [Accessed 15 June 2003].

Salazar Martinez, Rodolfo. 2003. Implementacion de la infraestructura nacional de datos geoespaciales de Ecuador. Available from: http://www.igm.gov.ec/articulos/geoinformatica1.htm. [Accessed 26 June 2003].

Sistema de Informacion Regional. 2003. Sistema de Informacion Regional. Available from: http://www.sirideec.org.co/inicio.html. [Accessed 26 June 2003].

USGS. 2003. USGS Hurricane Mitch Program. Available from: http://mitchnts1.cr.usgs.gov/projects/gis.html. Accessed 26 June 2003].

Corresponding Author:

Glenn Hyman
International Center for Tropical Agriculture
A.A. 6713
Cali, Colombia
Phone: 57 2 445 0000
Fax: 57 2 445 0073
Email: g.hyman@cgiar.org <mailto:g.hyman@cgiar.org>