Andean Spatial Data Infrastructure (ASDI)

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Key words: Spatial Data Infrastructure, Andean Spatial Data Infrastructure, Sub-Regional Spatial Data Infrastructure, Andean Community.

SUMMARY

The constant phenomena and changes around the world demand that countries, regions and national institutions are prepared to face the different challenges they present efficiently. For this reason, they need to have tools that allow them to be aware of these events. As a result, one of the basic and most important elements that they require is to represent early on the impact of these incidents over a specific geographic space, and for this, the importance of geographic data to make decisions is clear.

The Spatial Data Infrastructure emerging as a joint effort to ensure that the geographic data meets with the specifications, standards and other characteristics would allow them to fulfill the aforementioned goals. There are some efforts with different scope: global, regional, national, local and institutional initiatives.

This paper explains our proposal specifically of a Spatial Data Infrastructure at a Sub-Regional level: the Andean Spatial Data Infrastructure. It also explains the advantages and strategies for its implementation and its benefits for the development of society.

SUMARIO

Los constantes fenómenos y cambios que hay en el mundo exigen que los países, regiones e instituciones nacionales estén preparados para enfrentar los diferentes desafíos que estos presentan. Es por eso que se requiere contar con herramientas que permitan tomar conciencia de estos eventos, en consecuencia, uno de los elementos básicos el poder representar de manera temprana el impacto de los sucesos sobre determinado espacio geográfico, de allí la importancia de los datos geográficos para la toma de decisiones.

La Infraestructuras de Datos Espaciales surgen como esfuerzos conjuntos para lograr que los datos geográficos reúnan las especificaciones, estándares y demás características que les permita cumplir con el mencionado propósito, entre ellas tenemos iniciativas globales, regionales, nacionales, locales e institucionales.

Este documento expone la iniciativa generada para la implementación de una Infraestructura de Datos Espaciales a nivel subregional: La Infraestructura de Datos Espaciales Andina. Así también, explica las ventajas y las estrategias para su implementación y los beneficios esperados para el desarrollo de la sociedad.

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1. INTRODUCTION

Nowadays there are many Spatial Data Infrastructure initiatives in all spheres: global, regional, national, local and institutional. They work with the purpose to arrange for an efficient and effective spatial data infrastructure for decision-making. The Andean Spatial Data Infrastructure (ASDI) is a sub-regional initiative formed by the Member Countries of the Andean Community (Bolivia, Colombia, Ecuador, Peru and Venezuela) and it is based on the necessity to have efficient, effective spatial data, accessible for the benefit of the Andean Countries.

This paper describes the reasons for the implementation of the Sub-Regional SDI, explaining how the Andean Spatial Data Infrastructure is beneficial for the Member Countries of the Andean Community. It begins with a description of the Andean Community followed by a description of the scope of the Spatial Data Infrastructure. Then, there is some background explaining the actual needs of the Member Countries and the progress and problems with the implementation of the ASDI. This paper expresses the weaknesses and strengths around the ASDI and finally details the strategies planned for its implementation.

2. ANDEAN COMMUNITY

The Andean Community (CAN) is an international organization for the economic and social integration of five countries in South America: Bolivia, Colombia, Ecuador, Peru and Venezuela and the bodies and institutions comprising the Andean Integration System (AIS).

The key objectives of the CAN are: to promote the balanced and harmonious development of the Member Countries under equitable conditions, to boost their growth through integration and economic and social cooperation, to enhance participation in the regional integration process with a view to the progressive formation of a Latin American common market, and to strive for steady improvement in the standard of living of its inhabitants.

The Andean Presidential Council is comprised of the Presidents of the Member Countries and is the highest-level of the AIS, responsible for issuing guidelines about different spheres of Andean Sub-Regional integration. The political leadership and the main policy-making bodies are The Andean Council of Foreign Ministers and The Commission of The Andean Community, the last one is comprised of the Foreign Trade Ministers.

The executive body of the CAN is the General Secretariat (SGCA) and is empowered to formulate policy proposals. Its functions also include managing the sub-regional integration process; resolving issues submitted for its consideration; ensuring that Community commitments are fulfilled; and maintaining on-going links with the Member Countries and

working relations with the executive bodies of the regional integration and cooperation organizations.

The CAN has the capacity to generate supranational community norms for direct application and immediate effectiveness in the Member Countries, this means that the decisions of the Council of Foreign Ministers and of the Commission do not require ratification by national parliaments in order to become operative and enter into force on the date of their publication in the Cartagena Agreement's Official Gazette.

The CAN Member Countries have underscored the need to integrate themselves as a block to take advantage of the opportunities and face the challenges brought about by globalization. One of these challenges is the harmonization of environmental and sustainable development policies, in such a way that sustainable economic growth can be achieved to improve the quality of life of the population with due respect for the environment.

2.1 Andean Context

Located in South America, the five Andean countries together have 120 million inhabitants living in an area of 4 700 000 square kilometers. Moreover, the Andean countries have a valuable patrimony of natural and human resources, as well as historical and cultural experiences; In fact, the Andean Community is one of the areas with the wealthiest natural and cultural patrimony in the world:

- Approximately 25% of the planet's biological diversity is here and the Member Countries rank among the seventeen most biologically diverse countries around the world.
- 16,8% of birds, 10,5% of amphibians and 10,3% of the mammals worldwide are here.
- Natural area under protection represents 15% of the total surface area of the sub-region.
- Possess a valuable Andean cultural diversity.
- Has about 230 million hectares of forest surface, equivalent to almost 35% of the wooded surface in Latin America and the Caribbean and 6,5% worldwide.
- The forest surface includes an Amazon area of two million km² approximately; this means almost 50% of the Amazon territory in the South American Continent.
- The Andean Cordillera is the longest mountain chain in the world (7.250 kilometers) and has the highest glaciers located in tropical latitudes.
- The high mountain region is predominated by mountain systems between 2.500 and 4.500 meters above sea level. The mountains in this range include approximately 37% of the mountainous surface of South America.

These natural resources sustain the economic functioning of the Andean Countries, since approximately 20% of the GDP depends on the exploitation of natural resources like agriculture, fishing and mining. This makes it necessary to have a conscience about the significance of the resources and the necessary policies to guarantee sustainable development.

2.2 Problems

- Erosion is the principal problem of the land resource in the Andean Countries, affecting the development of cultivation, reducing the capacity for absorption of moisture and the availability of nutrients and organic material. Additionally, the Andean Countries contain 8% of the surface affected by desertification in Latin America.
- Heterogeneous spatial distribution of water levels due to diverse physical-climatic conditions in the sub-region. The water resource is 70% used for agricultural irrigation.
- Important increase of the fishery industry has caused the reduction of biomass of the main species, affecting the coastal ecosystems.
- Deforestation is one of the principal problems, as 90% of it is caused by uses for agriculture that are not sustainable.
- Increasing unplanned urbanization of the population, as a consequence of an accelerated process of migration, generates environmental deterioration as a result of vehicular congestion, noises, water and air contamination, among others.
- Water contamination by discharge of dangerous elements by industries like chemical, petrochemical and tannery.
- Air contamination mainly caused by the manufacturing industry, slash and burn agriculture, extractive oil and mineral exploitation, the use of fossil fuels in the process of energy generation and the automotive exhaust.
- "El Niño" phenomenon that is an oceanic-atmospheric alteration, which is most intense in the Pacific Ocean and affects severely the coasts of Peru and Ecuador. This phenomenon tends to increase precipitation and produces grave droughts in distinct parts of the world.

3. SPATIAL DATA INFRASTRUCTURE (SDI)

Some authors define a SDI as:

> *A spatial data infrastructure or framework is an essential pre-requisite to make use of spatial information in an effective and efficient manner. Such an infrastructure may be defined as a stable set of agreed rules, standards, procedures, guidelines and instruction for creating, collecting, maintaining, exchanging and using geographical information and also for contingency purposes (Brand, 1998).*
>
> *Tool to facilitate access to, and responsible use of geo-information at affordable cost in support of sustainable land management (Groot, 1997).*

Nowadays many public and private institutions in the Andean Countries have a lot of spatial data, but having spatial data is not enough. The most important thing is that this data have quality, interoperability, continuity and accessibility, as these characteristics ensure the best use of the data for decision making. As we have seen previously the Andean Community has on the one hand a large quantity of natural resources, similarity and continuity of geographic characteristics and on the other hand, a large quantity of problems with them. For this reason, it is vital to have an integrated vision of the territory and joint efforts to develop the ASDI to facilitate access to frequently updated geographic information of high quality.

The Federal Geographic Data Committee (FGDC) describes National SDI as:

> *National Spatial Data Infrastructure defined as the technologies, policies, and people necessary to promote sharing of geospatial data throughout all levels of government, the private and non-profit sectors, and the academic community.*
>
> *The goal of this Infrastructure is to reduce duplication of effort among agencies, improve quality and reduce costs related to geographic information, to make geographic data more accessible to the public, to increase the benefits of using available data, and to establish key partnerships with states, counties, cities, tribal nations, academia and the private sector to increase data availability.*

One important aspect of the SDI is that it minimizes the money spent redundantly, a very important topic to underdeveloped countries. The Andean Community is a sub-regional group of countries and needs to be viewed as a single territory in order to establish common solutions to its problems; the solutions are for all of the Sub-Region and for each Andean Country.

4. BACKGROUND

The different phenomena and changes in the world (Climate Change, El Niño Phenomenon, Erosion, Deforestation, Globalization, etc), demand that the Andean Community be constantly prepared in order to confront the problems and changes that they present. Consequently, the Andean Community needs to have elements to support decision-making for identification, implementation and evaluation of Community Norms.

In this context is very important to have tools and elements that permit us to investigate the impact of these phenomena and changes in a visual way, identifying the geographic space on which they were produced or the affected places in order to take the best actions. Then the geographic information plays one of the main roles to realize sub-regional studies over one continuous geographic space:

- They allow the early recognition of the economic, social, cultural, migratory, security, political impacts. For example: where is the poor population concentrated in order to find alternatives to promote the development of these places.
- They provide elements for the analysis of the impacts of different phenomena like: climate change, natural disasters, El Niño phenomenon, global warming, sea level rise, greenhouse gas emission, etc. For example: determine the percentage of deforestation and the most affected zones and generate policies to prevent this impact.
- They offer a global vision over the CAN Territory as just one region and the analysis and solutions are represented on this way too. For example: analyze the development of the highway infrastructure across the Andean Community to identify the roads that need to be built or improved in order to help the poor and remote places.

The SDI provides the spatial information or the location component to support the systems that permit the societies to operate efficiently both the natural and environment modeling understanding and management. This is a requirement for underdeveloped countries and is a response to economic, social and environmental concerns.

In the CAN Member Countries the National Geographic Institutions are committed to producing the official basic analogical and digital cartography information for use by other governmental institutions, the private sector and society in general. The accelerated increasing of technological alternatives like: digitization, Geographic Positioning Systems (GPS), aerial and satellite photography, and software for administration, analysis and dissemination of the geographic information has allowed the increased development of technological alternatives using this kind of information to get solutions to the society, one of the most significant are the Geographic Information Systems (GIS) directed to a wide variety of objectives.

The accelerated increasing use of new technologies causes omissions in the quality control of the basic data and thus the data can be misused, generating unnecessary duplicities, incomplete documentation, no interoperability, no comparability and incompatibility between spatial data from different sources, barriers that impede the data reutilization, along with the high financial and technical costs that they represent.

Due to these limitations, there are many International, Regional, National and Local efforts like: Global Spatial Data Infrastructure (GSDI), Permanent Committee for the Geospatial Data Infrastructure of the Americas (PC-IDEA), Infrastructure for Spatial Information in Europe (INSPIRE), Colombian Spatial Data Infrastructure (ICDE), etc. These are efforts oriented to establishing standards, methodologies, policies of information and best practices to guarantee that the production of spatial data preserve coherency between local, national, regional and global.

5. ANDEAN SPATIAL DATA INFRASTRUCTURE

The ASDI is a working group formed by the National SDI's, each National SDI works in direct coordination with the local SDI. The SGCA is in charge of the coordination and support of the National SDI's, acting as a catalyst for the national efforts and will work towards the alignment of the Regional and Global SDI. Furthermore, they will supply constant coordination with the National SDI and the Local SDI within each country and it will provide the necessary elements which facilitate the constant communication among them.

Actually, there are two existing National SDI's, one in Colombia (IDCE) and one in Peru (IDEP), that are working some years on this topic and have obtained sustainable achievements:

Progress in Colombia

- Standards of geographic information like metadata, quality of data, geospatial positioning, feature type catalogue
- Definition of the national framework data
- Elaboration of a clearinghouse which gathers information from national institutions
- Definition of institutional policies like documentation of the geographic data as part of the production process
- Definition of national policies of geographic information like agreements among national institutions for the production, maintenance, distribution and access to spatial data.
- Development of capacity building for the creation and development of the skill in the institutions and individually.
- Relationship with the SDI of high level as regional (Permanent Committee of Geospatial Data Infrastructure for the Americas), global level (GSDI) and low level as local and institutional.

Colombia has a good level of training courses about the topic of geographic data, SDI, etc. and it is propelling to share this knowledge with other countries of the sub-region. In this way, the National Geographic Institution of Colombia (Agustin Codazzi) with the collaboration of OAS prepares courses of Spatial Data Infrastructure with scholarships for employees of National Institutions of countries in South America interested in the implementation of this topic. It's important to mention this experience because of the collaboration that they can offer to the implementation of the ASDI.

Progress in Peru

- Promulgation of a National Norm to create the Coordinator Committee for Peruvian Spatial Data Infrastructure (IDEP), formed by the main national institutions that generate spatial and statistical data. IDEP is sustained by the Peruvian National Ministerial Decree[1] of the presidency of the Peruvian Ministerial Council that created the Leadership Committee of the IDEP.
- The Leadership Committee of the IDEP has been elaborating on the profile of the Project of Public Investment, the National Spatial Data Infrastructure Plan of Implementation and the National Spatial Data Policies.

Best practice:

It is important to mention the strategy used by Peru in order to get the support of the government leaders. It was based on the elaboration of an analysis about the budget which national institutions used in: the developing of geographic information systems, acquiring air photography and satellite images, obtaining spatial data and buying equipment related to the treatment of digital cartography. This analysis showed huge duplication of efforts and budget

[1] Resolución Ministerial M 126-2003-PCM - Constituting the Coordinator Committee of the Peruvian Spatial Data Infrastructure (IDEP). "El Peruano" News - April 27th, 2003

in all the aforementioned activities. This demonstrated the problem to government authorities and enabled their support for the creation of a National Spatial Data Infrastructure.

5.1 Purpose

The ASDI is a group of efforts of the national institutions and users of spatial data, who are oriented to guarantee that the production apply international standards to facilitate its interchange, reuse and access. One of the principal objects of the ASDI is to reduce the large budget applied to the duplication of spatial data production and it focuses its activities on: adopting international standards linking them to the own Andean sub-region characteristics to promote supranational norms on the interchangeability, interoperability, accessibility and use of spatial information, to produce fundamental framework data to which have access all the national institutions, to reduce the costs of duplicate production.

The SGCA's goal is to strengthen the National SDI's that exist and promote the creation of the other countries' SDI's. The countries that do not have a SDI are Bolivia, Ecuador and Venezuela: neither horizontal cooperation, nor agreement among the national institutions, principally Geographic National Institutions and National Statistical Institutions, though they are very interested in the creation of ASDI. These institutions, in some cases, use their own basic digital national cartography, creating problems to exchange information because they have different specifications and standards during their generation. Both institutions recognize the necessity of the National SDI that involves the efforts of all the actors, producers and users, these joint efforts would propose to generate common norms to facilitate the accessibility and interoperability of the spatial data inside the country.

The SGCA will be a catalyst for the national efforts and will work towards the alignment of the Regional and Global SDI. The ASDI will promote the use of best practices through vertical cooperation, searching for international cooperation and the constant coordination with the National SDI's.

As in many countries around the world, the geographic institutions are in charge of the digital national cartography, the idea is to promote that National Geographic and Statistical Institutions work together in order to be best prepared to provide the digital cartography using the standards and methodologies defined for the ASDI. Another main activity will be the preparation of rules, standards and a set of agreements to facilitate the dissemination of spatial data.

The ASDI neither seeks to collect the spatial data nor tries to create new ones with certain standards or following certain methodologies. Furthermore, this would be impossible due to the small economies of The Andean Countries. Rather, it seeks to optimize the utilization of the data available in Member Countries, propitiating the accessibility and interoperability of the data and eliminating obstacles that prevent its utilization.

5.2 Weaknesses

- Individualized management of the spatial data, each institution uses its own data and does not know what the others have.
- Different standards of content, specifications and protocols for the data integration.
- The same kind of data from different sources causes the duplication of efforts and use of financial resources.
- A small numbers of technicians have enough knowledge about terms used in a spatial data infrastructure (standards, policies, technologies, etc).
- Complexity in the implementation of norms which allow the accessibility of the spatial data and a lack of guidance for the implementation of international standards.
- The government leaders are misinformed about how important the geographic information tool is to the development of their societies.
- It is very difficult to share spatial data among the national institutions furthermore to know about what information they have.
- Deficit of information policies and legal definitions for the production and accessibility of spatial data.
- Incomplete documentation of available framework data and no updates.
- Lack of information about the technologies used in the institutional institutions.
- Lack of budget to support the National SDI's.

5.3 Strengths

- The interests of the principal national institutional producers and users of spatial data in the formulation of ASDI.
- There is a similarity and continuity of geographic characteristics in all the Andean Community that facilitate the common characterization.
- There are some standards defined inside the Andean Community that can be used in a sub-regional level.
- The General Secretariat of the Andean Community supports the project of implementation of the ASDI.
- It is possible to generate proposals of supranational norms in order to facilitate the establishment of the National SDI's.

5.4 Beneficiaries of the ASDI

The beneficiaries of the ASDI will be the community in general, through the enablement of decision-making by national and regional political leaders, particularly in sectors which require spatial data for specific purposes (Environment, Infrastructure, Public Health, Poverty Reduction, etc.)

5.5 Strategies of the ASDI

Capacity Building ensures that a person or an organization performs and produces properly. It provides an environment and context where individuals, organizations and societies could operate and interact. In order to guarantee the successful implementation of ASDI the Capacity Building is an important aspect to take in consideration.

Actually, there is a recently established working group made up of representatives from some key national institutions working voluntarily on this project. Though they require training in substantial aspects of the Spatial Data Infrastructure with the purpose of strengthening the National Capacities in concepts, standards, methodologies and promote the investigation and development of topics allied to SDI for the benefit of their institutions, countries and society in general.

These are the reasons why the SGCA has been programming a training course about SDI concepts with the support of Geographic Institution Agustin Codazzi of Colombia which has much experience about SDI and other topics related with geographic information. The SGCA is looking for the resources to implement it.

In order for a SDI to have an effect, it needs support at the highest level. This support is not just about promulgating laws that allow its creation and the use of norms to facilitate the access of the spatial data; it needs also the necessary resources for its implementation and development in the short, middle and long-term. Through the SGCA there is the possibility to get the adequate levels of political agreement, such as the Presidents of the Member Countries which are the highest authorities of the Andean Community.

In order to share the knowledge and the importance of the SDI to government leaders as a better tool for policy makers and the budget savings it brings, the plan is use the same strategy as the Peruvian SDI, first preparing an Andean survey and then presenting the result to the main country authorities.

The survey will be filled out by national institutions in the Andean Countries regarding the level of development of SDI in their countries. It will include: human and technological resources, policies, standards used, existence of object catalog, acquiring of space images, budget, etc. The intention is make a diagnostic that allows the formulation of a strategic plan for the formation of ASDI.

These actions do not make sense without the participation of the actors involved. For this, the plan is to organize meetings between the main national producers of spatial data, the principals of the Statistical and Geographical Institutions. The purpose is to show them the ASDI initiative and the creation of an Andean Committee to handle the initiative.

Another important aspect to consider is establishing a permanent ASDI workgroup, comprised of technical staff from the national institutions, which will be in charge of

elaborating the legal, political, and technical proposals that they consider pertinent. The SGCA is in charge of providing the elements to ensure continuous communication, for example, a recently established virtual space for the ASDI group, including the report of next meetings, virtual library of documents, interesting links, announcements, chat, etc.

One of the objectives of the ASDI workgroup will be the consolidation of National and Andean Models that will include: the definition of the framework data, the definition of technical specifications for the homogenization and production of the framework data, the proposal of agreements among the national institutions, formulation of the ASDI strategic plan, the proposal of norms for the regulation of the production and use of the geographic information, the proposal for transference of technology and best practices.

The proposals can be presented as policy proposals to the highest authorities of the Andean Community and after their approval can be converted to Supranational Andean Norms.

Another important aspect is the establishment of alliances with international organizations and national institutions involved with the development of the SDI to propitiate the transfer of technologies, best practices and experience to the Andean Community. It is essential to have enough economic support from international organizations interested in initiatives like this in order to achieve its sustainable development.

The construction of a base Andean Community map (a map with the five Member Countries: Bolivia, Colombia, Ecuador, Peru and Venezuela) in a scale 1:1 000 000 with the participation of all countries and containing the framework data defined for ASDI.

5.6 Conclusions

- The Member Countries of the Andean Community have similarly problematical environments, furthermore they know about the significance of natural resources for the development of their economies. These reasons give them the opportunity to propose common policies to facilitate the access to spatial information as an important tool to create a sustainable environment in the CAN.
- ASDI promotes the efficient use of resources because this will eliminate the duplication of the resources used by the national institutions to generate and maintain spatial data and provides a mechanism for sustainable increases coherent with the sub-regional goals.
- The ASDI is the product of necessity of the Andean Countries to obtain a mechanism that facilitates the collection of the opportune and appropriate elements for decision-making for the sustainable development of the Member Countries.
- There is the concern of the National Institutions and The General Secretariat of the Andean Community for the implementation of the ASDI. Both of them can exchange synergies to collaborate with the implementation of the ASDI. The proposal capacity of the SGCA is an advantage to get the support of the government to obtain the goals defined for ASDI. However, the cooperation of international organizations is necessary to guarantee the implementation and maintenance of ASDI and to promote the creation of the National SDI in the Member Countries that do not have them yet.

- The National Institutions should assume a leadership role in the coordination of geospatial information. They could act as more than producers of spatial data. Instead they have the capacity to propose norms that will benefit their countries and the five Member Countries.
- It is important that ASDI take advantage of the knowledge of other SDI initiatives in all spheres and the experiences obtained by Peru and Colombia in the implementation of their National SDI's in order to use best practices to guarantee the better implementation of the Andean Spatial Data Infrastructure.

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BIOGRAPHICAL NOTES

Gloria del Pilar Vasquez Perez is a Systems Analyst working at the General Secretariat of the Andean Community, which is an international organization for the economic and social integration of five countries in South America: Bolivia, Colombia, Ecuador, Peru and Venezuela. Her activities are related to the coordination of the construction of the Andean Spatial Data Infrastructure (ASDI) that consists of a Spatial Data Infrastructure (SDI) at a sub-regional level corresponding to the five countries that constitute the Andean Community. Her personal interest is to collaborate on ideas that indirectly contribute to the development of the countries of the CAN. For example, through the ASDI, She looks for efficient uses of resources used by the national institutions to generate and maintain spatial data and the use of the geographic information for decision-making on specific and important areas like the Environment, Infrastructure, Public Health, Poverty Reduction, etc.

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