

RELATIONSHIPS OF CARTOGRAPHY, GEOGRAPHIC INFORMATION SYSTEMS AND THE MEXICAN SPATIAL DATA INFRASTRUCTURE (IDEMEX)

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KEY WORDS: Cartography, GIS, Information, Management, National, Spatial Data Infrastructures

ABSTRACT:

This paper outlines relationships among the development of cartography, GIS and the Mexican SDI (IDEMex) at the National Institute of Statistics, Geography and Informatics (INEGI) of Mexico. An overview of geographic information development is introduced, as produced in the period 1968 - 1988. The National Statistics and Geographic Information Law, defines the National Geographic Information System (NGIS), setting its principles and concepts. The first part of the nineties witnessed the change to the digital format, providing for the general advancement and use of cartography in the context of the NGIS. Following worldwide tendencies and according to national needs, INEGI has launched the initiative to develop the National Spatial Data Infrastructure, IDEMEX, including related tools and standards, intensive use of modern information and communication technologies, solution of issues related to access and distribution, and the integration of national geographic information according to the NGIS in the context of the IDEMEX.

1. INTRODUCTION

There is a relationship between cartography, Geographic Information Systems (GIS) and Spatial Data Infrastructures (SDI). This is not so much considered among those who have to deal with modern concepts regarding the optimal use of geospatial information.

Demands for geographic and statistical information lie in the core of decision taking. The last days of the XXth. Century witnessed the start of a growing awareness on the importance of geospatial information, how this increase is more and more related to decisions taking in the realm of geographic information for the best use of existing cartography, GIS development and the establishment of operational SDI's

SDI's are conceived for the best use of data and information, including the important contribution of Statistical Information. Through this merging of Statistics and Geographic Information is that both acquire a real meaning for decision takers through the process of data generation, its conversion to structured information, and the development of informed knowledge.

In this paper the intention is to bring together the above ideas and establish the relationships between geographic information as represented by map products, GIS as instances of a higher level and the technical and administrative tools which can be applied to both cartography and GIS in terms of the IDEMEX.

A brief historic account of geographic information development in Mexico is given and considerations are included as related to new and modern geographic knowledge development schema connected with the conformance to technological development, globalization, and Economic Sustainable Development. The paper continues with a description of Cartographic and Geographic information development at the General Directorate of Geography (DGG) of the National Institute of Statistics, Geography and Informatics (INEGI).

Reference is made to the legal frame as represented by the Statistical and Geographic Information Law (LIEG) and its relationship with the National Geographic Information System (NGIS) Some issues contained in the Law are discussed, to arrive later to the modernization of the geographic activity at INEGI with digital technology, going on to build the SDI of Mexico, and establishing the relationships with both cartography and the NGIS.

2. A BRIEF HISTORIC ACCOUNT

The history of geographic information in Mexico can be traced up to the prehispanic times. In the Colonial period Cartography was devoted to the general knowledge of the territory through the works of some scholars and institutions for the geographic location of main economic activities.

During the XIXth. Century, Mexico tried to consolidate as a new Nation. There was not so much chance to go into developing geographic knowledge, though there were some efforts from scholars as Antonio Garcia Cubas and the works of Baron Alexander Von Humboldt.

In 1822 the government began to organize the territory, so a Commission was established to elaborate the first General Map of Mexico. In 1839 the Mexican Society of Geography and Statistics compiled a Geographic Chart of Mexico. In 1856 a Geographic and Historical Atlas of Mexico was elaborated. In 1877 The Geographic Exploration Commission was created to develop a new General Map of Mexico.

In 1913 an Agreement to unify geodetic systems in North America was signed with the U.S.A and Canada, by which Mexico adopted the reference system becoming later the 1927 North American Datum, as well as the Clarke 1866 Ellipsoid.

In the first days of October 1968 the Commission of Studies for the National Territory (CETENAL) was created, with the responsibility to develop the national inventory of natural

resources and infrastructure through the production of the Topographic Map Series at the scale of 1:50,000 as well as the corresponding natural resources mapping. This Commission was the forerunner of the actual DGG and the official main organization dealing with the generation of geographic information at the. DGG is the prime basic geographic information provider.

3. GEOGRAPHIC INFORMATION DEVELOPMENT

The analysis on the actual geospatial information status shows that activities have been characterized by the production of a huge volume of analogical cartographic data in several government organizations. Through a modernization of activities beginning in the early 90's the change to the digital approach has been growing both in extent and coverage, where a high share of the activities have been devoted to convert analogical data and mapping to the digital format.

Considering the national extent, data integration in appropriate schema of use does not exist, that is, there is not a full formal geospatial information commitment aimed to foster responsible knowledge corresponding to the data-information-knowledge scheme, nor a well developed integration with statistical information. What is appreciated is a general deficiency of geospatial information administration systems, in most cases existing data and information are not known to decision takers, data are not shared, have difficulties for access, are of unknown or questionable quality, are not standardized and are very much dispersed among the several organizations. This is the national context.

INEGI is responsible for the production of a high share of fundamental and basic digital data and mapping for the country. However, the scope should cover all organizations in the federal, state and local governments, including the academia and private sectors. This is why INEGI has taken the initiative to develop the IDEMEX.

4. GIS DEVELOPMENT AT INEGI

GIS's at INEGI is considered in two different contexts: the operational one regarding them as tools for the analysis and treatment of data and the other as a concept developed through the modernization of geographic activities, which we call the institutional approach.

5. THE OPERATIONAL GIS APPROACH

A common definition is that any GIS is a computerized based system used to capture, store, manage, edit, display and present geographically referenced data. According to Burrough, (1986), GIS's are defined as a set of powerful tools for the collection, storage, retrieval at will, transform and display of real world spatial data for a particular set of purposes. Following Aronoff (1989) GIS are any set of manual or computerized procedures used to store and manipulate geographically referenced data.

6. THE MODES OF OPERATIONAL GIS.

GIS have different meanings according to specific purposes, synthesized through three distinctive modes, that is a) the map, b) the database and c) the space analysis mode.

GIS's can be seen as cartographic production systems or at least as geographic information display systems. In the cartographic process each data set is represented as a map or as a map layer, usually in a raster format.

In the database approach, predominant within the community having a computer background the importance lies on the availability of a well implemented database.

The third mode puts all the weight on space analysis. This point of view is the most accepted within the GIS community and can be used to establish a difference with other GIS's. The main difference with any cartographic system lies precisely in the analytical capacities; cartography as an information tool for such tasks is limited.

7. THE INSTITUTIONAL APPROACH OF GIS

GIS and SDI concepts are not new in Mexico if the NGIS is considered. According to the LIEG, this GIS is defined as the *"Data set produced by the public institutions, organized under a predetermined conceptual structure which allows showing the situation and interdependence of economic, demographic and social phenomena, as well as its relationship with the physical medium and the territorial space."*

A strong bond between the NGIS and the IDEMEX exists as we shall see later, since in fact, this can be included in the scope of the former and is part of its integration and development. Since the Law was promulgated in 1980, the SDI idea was already embedded, though not implemented. Prior to the 90's, geographic information was becoming digital in several media according to technological change and influence of computer technology: the necessity to go digital became clear.

The purpose materialized when beginning 1992 a strong effort was implemented to establish the System by developing an operative NGIS composed of several modules and taking care of the three modes of GIS as explained before.

8. GIS AND CARTOGRAPHY

Cartography has been defined as the science, art and technology of making maps and its study as both scientific documents and works of art, or as the discipline dealing with the conception, production, dissemination and study of maps.

From a definition viewpoint it seems somewhat difficult to establish a relationship between GIS and Cartography, except when systems include the geographically referenced spatial data concept. However, the concept with cartography is not at all absolute from this perspective as any piece of data can be geographically located and entered in a database without necessarily coming from a map, though maps are a good source and the most common geographically referenced data for GIS.

Both cartography and GIS have to deal with geographic information and are communication instruments for decision

taking, as both, with different capacities, allow for the treatment and analysis of geographic information.

Regarding the dependence relationships GIS's are capable of generating outputs with all cartographic formalities, including media different from the traditional.

GIS arrived on the cartographic scene with a strong impact, where it is of some concern for the future of cartography, with the development of automated systems and the advent of GIS.

There were times when cartographers were appreciated scholars who spent a whole life creating one or a few maps. Facing the up to date growing demands for geographic useful information, cartographers now have to see themselves seated facing a computer monitor and feeling confused and distrustful without not so much confidence on what they are doing. This feeling is hard to eliminate if the ideas are not clear. We feel this is a negative relationship between cartography and GIS.

The solution seems to be on the development of a new "cartographic feeling" in an environment of new technological developments where GIS should be regarded as one of the main subjects, concepts and ideas and not just for operative training on computer hardware and software.

The relationship between cartography and GIS can be best visualized from a practical point of view. One of the modes of GIS is the cartographic one, but this is mostly given in the context of applications and not necessarily as an objective reality. Computer Assisted Mapping (CAM) has a specific production objective, but lacks the analytical capacities of a GIS. On its part, GIS include cartographic capacities, which being important have not the same weight as the analytical. However, GIS depends basically on cartography for data capture, which in many cases has to be converted to a digital format, structured and put into a database, processed as required and finally given some sort of output.

9. THE IDEMEX

Mexico is under a technological and organizational imperative to develop the national SDI in answer to demands as imposed by globalization, sustainable development and explosive technology increase. There is a marked awareness in the high decision centres about the importance of geospatial information, which on the other hand sets increasing demands for useful information for everybody through defined schema of responsible management.

Since 1997 INEGI developed the idea around the SDI. In a general context, three stages can be identified; one is the historical frame, then the change to digital, and thirdly the compliance with the advance of technology and new demands.

The first stage in the XIXth. and part of the XXth. century witnessed the first formal productive efforts of geographic information through cartography at small scales, as stated in the first part of this paper. The second stage in the 90's saw the modernization of geographic activities with digital technology.

In the third stage a pressing need arose to coordinate and standardize the information. The effort was devoted to adopt efficiency criteria for the integration and management of geospatial information in terms of availability, knowledge of

its characteristics, considerations on access and distribution and the intensive use of information and communication technologies. The idea about the IDEMEX began to develop.

The IDEMEX is conceived to support the integration and development of the NGIS, as well as a tool for the management of the information contained in it, facilitating its operation, and having in mind to provide for the best geographic information service.

The basic technical components of the IDEMEX are those next listed:

- Catalogues and fundamental data, Metadata and Clearinghouses
- Access, Interoperability and distribution
- Norms and standards development
- Construction of alliances, institutional strengthening and capacity building

There is support for the IDEMEX from all sectors which recognize there is a need for cooperation under a coordinating body, the INEGI. There is a growing awareness about the application of agreed standards, as well as to the need to avoid duplicities and adopt rationalization production schema, making geospatial information available for all interested parties. The information is be looked at with a vision of future.

There are some official basic concepts regarding geospatial information in connection with the IDEMEX: First is the need to upgrade the NGIS according to present needs, so providing a further step to democratize geospatial information. Both the statistical and geographic information systems must satisfy the information requirements of all sectors in a participating context.

In terms of national requirements there is a need to promote communication and interchange ideas and experiences, as well as to fortify links and agreements for updating the NGIS and the establishment of common agreed standards. There is also a need to come to terms with other organizations, looking for complementarities and rationalization of the production.

As a strategy to promote awareness and commitment about the IDEMEX, in 2003 INEGI organized a National Geography Convention attended by representatives of all sectors, especially the official one. The objective was to position geographic information as a strategic resource for the building of the Mexico of future, with the purpose to attain consensus and a committed participation and cooperation. In this context, the main subject was the IDEMEX. This has been followed yearly with other meetings where the SDI has been central.

There are some interesting aspects regarding the organization of the IDEMEX to put it in the proper frame: with the LIEG and the NGIS, with the consultative and participation committees established by the law for the integration and development of the NGIS, with the National Statistical and Geographic Development Program (PRONADEIG), and with the sexennial National Development Plans.

Regarding technical committees, the most important one is the Technical Consultative on Geographic Information Committee, integrated by high level officials from the Federal and State governments. The main function is to issue opinion and define priorities for the PRONADEIG. Given the high level of this

Committee, the strategy has been to put the IDEMEX under its umbrella. There are other committees specified by the law, of a more executive character.

The PRONADEIG is an instrument calling for the ordering and regulation of productive activities, establishing priorities as set by the corresponding Consultative Technical Committee. This program, elaborated by INEGI, has specific considerations connected with the IDEMEX. On the other hand, there is a relationship with the National Development Plans, the main planning document of Mexico, issued every 6 years.

One of the resolutions from the Convention was to disseminate the idea of the IDEMEX by using mainly the website of INEGI; we are implementing this, where forums are open for feedback, interaction between interested parties, consultation, discussion and analysis of key issues, with the general idea to upgrade awareness and interest about the IDEMEX.

INEGI, as an institution has contributed to the IDEMEX, through a sustained geospatial information production, development of conceptual issues related to data, continuous metadata generation, establishment of a clearinghouse and gateway node, and giving attention to standards compilation and generation.

10. RELATIONSHIPS BETWEEN THE IDEMEX, NGIS AND CARTOGRAPHY

There are four important factors in GIS; that is, hardware, software, dataware and liveware. Enough is already known about HW and SW. Regarding data, it is of a growing concern that the output from the system is only as valid as the data input. On the other hand, while HW and SW are becoming more powerful and cheaper, it is recognized that the most expensive part of any GIS is the collection and processing of data and this is not universally recognized. This fact brings to attention the vital importance of creating or gaining access to reliable and accurate collected and maintained spatial data, which on its part establishes a relationship of GIS and cartography with SDI.

Another relationship with SDI is that prior to the availability of comprehensive GIS, sample data from cartography were important for two reasons. First, they were the only data available. Secondly and not often recognized, they approached the maximum amount of information a user could process manually. With the aid of computer based GIS, decision makers are asking for much more detailed data; but this approach is somewhat questionable since the tendency now is to use significant data, the most important and used one, which calls for the concept of Core or Fundamental Data as conceived in SDI's and metadata development.

Another requirement is that data as collected for a GIS should be multipurpose in nature since the costs involved in collection, indexing and storage require it to be collected once and made available. This is also connected with SDI.

Also, in a SDI environment as related to GIS, standards have to be set and met by the data providing community. Standardized metadata contained in a digital file are required.

Regarding liveware, to operate a GIS people or operators are needed, and so GIS education is necessary. Operators need to be computer literate and understand the functions available in a

GIS. Few people today are adequately trained in all of these areas, nor there are much of quality training programs available. This calls for what is known as capacity building in a SDI environment.

Capacity building as well calls for the fact that technicians can perform some of the tasks required to operate a GIS with only a little training, but the person who is over the operation and whose responsibility is to take decisions, must be professionally trained.

More attention is being paid now to geospatial information management within the frame of a greater rationalization and efficiency, without neglecting the productive aspects are now more diversified and include new sceneries. To this we can add the notion to share existing geographic information through the IDEMEX. The IDEMEX represents a modern resource associated to the management and distribution of geospatial information, within an approach adapted to the design and implementation of now necessary administrative schemes.

In this context, a set of necessities associated to the dynamics characterizing geospatial information has been detected:

- To know where the information is, describe, and standardize it,
- To share, facilitate transference, access and use
- To establish an effective understanding between producers and users,
- To rationalize the production, and handle it with efficiency.

The IDEMEX comprises different actors, where everyone is in charge and responsible for its own information, which implies, from the point of view of implementation and service, the existence of a set of distributed databases.

SDIs can occur with different geographic coverages, from institutional and local infrastructures, to those of national, regional and global extent. In the first case, we are adding a new category in reference to infrastructures which can be integrated in the level of big producing organizations handling significant and diversified geospatial data.

There is a set of conditions which have to be considered in connection with the implementation of the IDEMEX, which are centered in the total recognition of its importance and necessity, as well as on the existence of a strong political will to come with the planning and implantation and to assume the commitments of the case, particularly the recognition on the necessity to also make a strong effort to come to terms of agreement between the different actors, as well as paying careful attention to all technical, legal, administrative and of financial character aspects including the necessary prevision for continuous development and maintenance.

11. CONCLUSION

This paper has been devoted to explain the way we at INEGI think of the relationships existing between Cartography, our NGIS and the IDEMEX, beginning with an account of cartography developed through time as a communication tool for planning of the social and economical development of the country, then through the emergency of the GIS technology which came to upgrade cartography and materialized in the NGIS by setting new stages and paradigms as conceptually defined by the Law, which are under actual implementation ,

and in the third place through the necessity for the implantation of new and good administration and best management means for the geospatial information by giving way to the IDEMex. This is by no means a new scenery in which we have to act and perform for the best of the country in the context of the Sustainable Economic Development.

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