

National Geostatistical Framework, as an example of success in Mexico for the linking of Statistical and Geographic information

Luis Gerardo Esparza Ríos
National Institute of Statistics and Geography (INEGI), Aguascalientes, Ags., Mexico
gerardo.esparza@inegi.org.mx

Abstract

This document presents a summary of the experience and efforts made by Mexico for the integration of statistical information and geographic information through the National Geostatistical Framework (MGN For its acronym in Spanish) and how this process conducted by the National Institute of Statistical and Geographic Information (INEGI For its acronym in Spanish) Is consistent with the five guiding principles of the Global Statistical Geospatial Framework (GSGF), adopted at the sixth annual meeting of The United Nations Committee of Experts on Global Geospatial Information Management (GGIM) and endorsed by the 48th Statistics of the United Nations in March 2017.

Keywords: geostatistical framework, linkage, georeferencing, geostatistics

Introduction

The National Institute of Statistical and Geographic Information (INEGI) is an autonomous public body established in 1983, which is responsible for regulating and coordinating the National System of Statistical and Geographic Information (SNIEG For its acronym in Spanish), as well as to capture and disseminate information from Mexico as to the territory, the resources, the population and economy, that allows to know the characteristics of our country and to help the decision making. The main objective of INEGI is to ensure that the System provides society and the State with quality, pertinent, truthful and timely information in order to contribute to national development, under the principles of accessibility, transparency, objectivity and independence.¹

INEGI shelter the areas of statistics and geography in the same national institution, thus allowing the development of both disciplines to be in constant interaction, which has strengthened the consolidation of SNIEG and therefore benefit the country widely. This integration has made it possible to georeferencing many relevant statistics and determining the exact location of economic and social inequalities, the general needs as well as the damages caused by natural disasters and other emergencies that help to improve public programs and maximize resources for the benefit general of people and territory.²

The document is structured in five main sections: the first presents an overview of the National System of Statistical and Geographic Information (SNIEG); The second describes the activities of INEGI as a generator of statistical and geographical information; The third describes the Geostatistical Framework of Mexico and the derived cartography, as well as its applicability and in Censuses and Surveys. The fourth section describes some tools and projects as examples of the process of linking statistical and

¹ About INEGI, published on the official INEGI portal (<http://www.inegi.org.mx>).

² Integration of statistical and geospatial information. More than 30 years of experience georeferencing information in Mexico, INEGI, 2017.

geographical information. Finally, the fifth section discusses the Global Statistical Geospatial Framework (GSGF) proposed by the UN-GGIM Expert Group for the Integration of Statistical and Geographic Information (EG ISGI), and how Mexico and the National Geostatistical Framework maintain Alignment with its five guiding principles

1. National System of Statistical and Geographic Information (SNIEG For its acronym in Spanish) ³

The National System of Statistical and Geographic Information (SNIEG) has the purpose of providing society and the state with quality, pertinent, truthful and timely information, in order to contribute to national development and is defined as: A set of State Units (UE For its acronym in Spanish) organized through the Subsystems, Coordinated by INEGI and articulated through the National Information Network, with the purpose of producing and disseminating Information of National Interest.

In this context, SNIEG is composed of the National Consultative Council, the National Subsystems of Information and the INEGI as coordinating agency. The latter is headed by a Governing Board (consisting of a President and four Vice-Presidents). The National Subsystems of Information (currently: Demographic and Social, Economic, Geographical and Environmental, as well as Government, Public Security and Justice) have the objective of producing, integrating and disseminating information according to the theme that corresponds to them and have several Specialized Technical Committees (CTE For its acronym in Spanish) coordinated by an Executive Committee by Subsystem. The CTE function as collegiate instances of participation and consultation, created by agreement of the Board of Government of INEGI to support the National Subsystem of Information to which they are attached; In which the State Units participate, which are administrative areas that have attributions to develop Statistical and Geographic Activities or that have administrative records that allow obtaining Information of National Interest.

As part of the System, INEGI has the responsibility of producing statistical and geographical information, as well as the Central Unit Coordinating the System, which involves regulating and coordinating it, maintaining its efficient operation, by regulating Statistical and Geographic Activities that Carry out the State Units, establish the rules of operation of the Collegiate Bodies, develop guidelines for the development of the System's regulations and integrate a National Catalog of Indicators, among other functions.

2. INEGI as generator of statistical and geographical information

Mexico has in INEGI a responsible, reliable and solid institution for the generation of information on demographic, social, economic and environmental phenomena and its relation with the national territory. The statistical and geographical information that it produces and which it makes available to the State and society, contributes to the development of the country, since it allows the authorities and representatives of the various sectors to have a better knowledge of the reality to base their decisions, as well as To evaluate the results of their performance. In addition, it is a fundamental input for academic research that contributes to understanding the progress of the country and our environment.⁴

³ What is the SNIEG, published in the official System Portal (<http://www.snieg.mx>)

⁴ Institution in the service of Mexico, published in the official website of INEGI (<http://www.inegi.org.mx>)

In the statistical area, the Institute generates basic statistics, which obtains from three types of sources: censuses, surveys and administrative records, as well as derived statistics, through which it produces demographic, social and economic indicators, as well as national accounting.⁵

1. Census. They are data collection operations of the entire universe of study at a given time; The Institute raises three censuses: Population and Housing, Economic and Agricultural.
2. Surveys. They are data collection operations that capture information from a sample of the study universe. They are performed in homes and establishments, and are classified into two types: regular and special.
3. Administrative records. The INEGI produces statistical information that comes from the data that are integrated in the procedures of public institutions. The statistics that are generated from these sources are: Vital, Social and Economic.

In the geographical area, the Institute generates information on different topics to know the characteristics of the territory and the environment, which offers through printed cartography and digital cartography.⁶

1. Data groups. They include geodetic reference framework; Coastal, international, state and municipal boundaries; continental, insular and submarine relief data; cadastral, topographic, natural resource and climate data; as well as geographical names.
2. Environmental indicators. They include atmosphere, water, soil, flora, fauna, as well as hazardous and solid waste.

3. National Geostatistical Framework (MGN For its acronym in Spanish)

3.1 Description

In the absence of a clear territorial division of the states and municipalities at national level, INEGI created the National Geostatistical Framework (MGN) in 1978 with the objective of associating census information and statistical survey with the corresponding geographic area.⁷

It is a unique and national system designed by INEGI to correctly reference the statistical information of the censuses and surveys with the corresponding geographical places, provides the position of localities, municipalities and entities of the country, using geographical coordinates. The information of the Geostatistical Framework is an aid in the delimitation between entities and municipalities, especially in the places where the administrative political bounds are undefined.⁸

⁵ Generator of statistical information, published on the official INEGI portal (<http://www.inegi.org.mx>).

⁶ Generator of geographic information, published in the official portal of INEGI (<http://www.inegi.org.mx>).

⁷ National Geostatistical Framework, presentation INEGI, 2017.

⁸ National Geostatistical Framework, published on the official INEGI portal (<http://www.inegi.org.mx>).

In its first level of disaggregation, it divides the national territory into areas with identifiable limits in the field, called Geostatistical Areas, with three levels of disaggregation: State (AGEE For its acronym in Spanish), Municipal (AGEM For its acronym in Spanish) and Basic (AGEB For its acronym in Spanish), which may be urban or rural. The codification of each geostatistical area provides unique and specific identity of the geographic space that occupies in the country, a situation that allows the association of the statistical and geographical data that it contains.⁹

The current levels of MGN disaggregation, as a result of its latest update based on the Georeferencing of Domiciles 2012, the Agricultural Survey 2014 and the Intercensal Survey 2015, correspond to the following:¹⁰

- 32 State Geostatistical Areas
- 2 458 Municipal Geostatistical Areas
- 4 562 Urban Geostatistical Locations
- 50,821 Rural Geostatistical Locations
- 2 323 131 Geostatistical blocks
- 187 326 Control Areas
- 2 398 627 Roads
- 30 299 681 External numbers

3.2 Applicability in Censuses and Surveys

National Geostatistical Framework allows the linking of statistical and environmental information with geographic information and is part of the basic information infrastructure of the Statistical Information Subsystems (Economic, Sociodemographic, Government, Public Security and Justice).

In order to carry out the census and the surveys it is necessary to define, in the geographical scope, the study areas; Which is feasible thanks to the MGN. In order to carry out any census, the main thing is to know where the economic establishments, the dwellings, the agricultural or forestry production units, or whatever the observation unit under study are located. For the survey of the various National Censuses it is necessary to do a previous work that allows to identify all the inhabited places, without exception some.⁹

The MGN, besides guaranteeing geographic coverage and national monitoring of the Economic Censuses, Population and Housing Census, Agricultural Census and Surveys, is a tool for the stages of planning, surveying, treatment, presentation and dissemination of the information collected in field (Fig.1).⁹

⁹ National Geostatistical Framework, published on the official INEGI portal (<http://www.inegi.org.mx>).

¹⁰ National Geostatistical Framework, presentation INEGI, 2017.

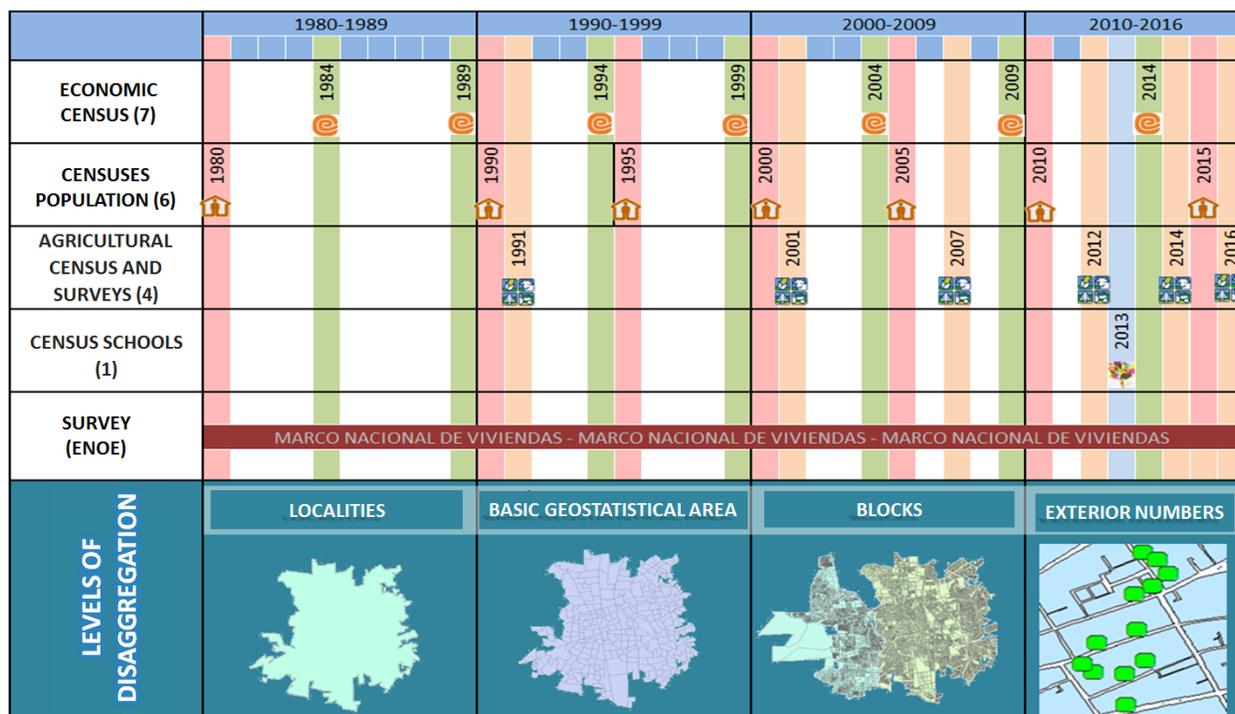


Fig. Employment of MGN in Censuses and Surveys ¹¹

The codification of each geostatistical area provides unique and specific identity of the geographic space that occupies in the country, a situation that allows the association of the statistical data contained therein and the recognition of geographical units by different users and the integration of information from various sources. It is one of the greatest challenges and needs of a geographic information system; The Federal Government ordered that the names and codes of federal entities, municipalities and localities that manage the different dependencies of the public administration must be homologated. ¹²

In this sense and with the purpose of generating a Single Catalog of Keys of Federative Entities, Municipalities and Localities and establishing a permanent updating mechanism, the activities of catalog homologation were carried out with the participation of the Secretariat of Social Development (SEDESOL (For its acronym in Spanish)- Opportunities) Secretary of Public Education (SEP For its acronym in Spanish), Health Secretary (SS For its acronym in Spanish) and the National Institute of Statistics and Geography (INEGI). ¹²

This resulted in the Single Catalog of Geostatistical Keys of Federative Entities, Municipalities and Localities, which facilitates the interoperability between the registers of the different Units of the State and the integration of statistics from administrative and geographic registers, which support the management Transparency in a transparent manner.

¹¹ National Geostatistical Framework, presentation INEGI, 2017.

¹² National Geostatistical Framework, published on the official INEGI portal (<http://www.inegi.org.mx>).

3.3 Cartography Geostatistical ¹³

The graphic representation of the National Geostatistical Framework and the territorial integration of the country is concretized in the Geostatistical Cartography, made up of maps, sketches, plans and catalogs at different geographic levels of representation, which support planning, execution, processing and Dissemination of results of the censuses and surveys developed by INEGI.

The objectives of geostatistical mapping are as follows:

1. To elaborate and update the cartographic products that guarantee to identify, locate and refer geographically the totality of the economic establishments, the dwellings and their inhabitants, as well as the agricultural and forestry production units existing in the country.
2. Use automated methods that improve the quality and speed of cartographic production.
3. Desarrollar sistemas de información geográfica, que permitan la consulta ágil de la información estadística obtenida de los censos y encuestas con su ubicación, así como su relación con los diversos elementos geográficos, entre ellos la orografía e hidrografía.
4. Disseminate the census results through thematic mapping and the publication of atlases.

The global process of elaboration of the geostatistical mapping is a permanent update of the cartographic information through different operations carried out by INEGI, as well as by various public and private institutions, which is analyzed and prepared in a cabinet for its updating in the field. By permanently developing the field updating and validation works, the information contained in the cartographic products is maintained and, in turn, by preserving and training the technicians in cartography, the quality of the information is guaranteed, thus avoiding improvisation Prior to the census surveys.

With the support of various computer tools and in order to have a computer system capable of relating statistical information to the geographic space to which it belongs, an endless number of automated techniques and procedures have been carried out to simplify the processes of production and updating of cartography. National Geostatistical Framework. To improve the geostatistical mapping the following changes were made:

- Automation in cartographic production
- Scales that allow to appreciate in more detail the information
- Diversity of products, which make it possible to accurately recognize the location of any street, block or land in the country
- Topographic map scale 1:50 000, available for the whole national territory
- Geostatistical mapping, as a result of censuses and surveys
- New printed products (such as Atlas) and magnetic media

¹³ National Geostatistical Framework – The Geostatistical Cartography, published in the official INEGI porta (<http://www.inegi.org.mx>).

4. Examples of the process of linking statistical and geographical information

The experience of Mexico and INEGI regarding the multiple projects that link statistical and geospatial information is important. In addition to the advantages of having the areas of statistics and geography in the same institution, INEGI has made important advances in various projects and solutions that relate statistical data to geographic data, which goes beyond census information Or surveys of socio-demographic or economic nature, also considering environmental aspects.

4.1 Geomatic Solution for the Census Operating Process ¹⁴

Application based on the Digital Map of Mexico that allows conducting the operational process of a census event through four modules: Operational Planning, Cartographic, Monitoring, Geographical Coverage and Progress, and Closing.

1. The Operational Planning Module. This web application optimizes the operational planning of the event by assigning control sections graphically, as well as the management of operational figures and graphical assignment of weekly work, with a systematic visual follow-up of the control sections.
2. The Cartographic Module. It is a local / mobile cartographic application, made to capture the georeferenced phenomenon, as well as the map updates detected in the census operation in a GIS type tool for a particular purpose. At the end of the process, all the cartographic updates made in the field are verified in situ, so that they can finally be updated in the cartographic database.
3. Module for monitoring, progress and geographic coverage. The tracking system is a web application that allows the integration of the information and facilitates the monitoring of the progress and geographical coverage through the use of tools that allow a better analysis of the integrated information. Graphically shows the progress and coverage of the block census, AGEB and Localities. The packets are integrated consistently, so that once it reaches the central server, the system is updated with a delay of minutes.
4. Closing Module. It consists of a series of web applications and desktop to take advantage of the information of the census event. Spatial Analysis Example: You can create areas of influence and make crosses with other layers of information and download them in KML and quantify the information in the analysis area.

¹⁴ Integration of statistical and geospatial information. More than 30 years of experience georeferencing information in Mexico, INEGI, 2017.

4.2 The National Directory of Economic Units (DENUE For its acronym in Spanish)¹⁵

It is an updated directory of all the economic units of the country, which materializes the effort to create a national economic registry, generated by the information collected by the Economic Censuses providing their identification and location. In its ninth edition, DENUE publishes the data of 5 million 39 thousand 911 of economic units of all sectors of economic activity - except the agricultural and forestry activities - that the census has found active in the national territory.

The data provided by DENUE allow the identification of economic units by type of legal organization (physical or legal person), economic activity and / or size (stratum or number of employees); As well as locating them in Mexican territory by regions, localities, blocks and streets.

Currently, the DENUE offers information on two types of economic units:

- The establishment: economic unit that in a single physical location, permanently settled in a place and delimited by buildings and fixed facilities, combines actions and resources under the control of a single owner or controlling entity to carry out any economic activity is for the purpose of Profit or not. Includes dwellings in which economic activities are carried out.
- The company: organization, owned by a single legal entity, which carries out one or more economic activities, with autonomy in making marketing, financing and investment decisions, having the authority and responsibility to distribute resources according to a plan or Strategy of production of goods and services, being able to be located or to operate in several domiciles

The Directory excludes economic units that carry out itinerant activities or those in which the premises in which the economic activity is carried out are removable and are removed daily.

In relation to the National Geostatistical Framework, the economic units that the DENUE includes are located in the 32 states; 2 thousand 458 statistical municipalities; 4 thousand 545 urban statistical localities and 13 thousand 295 rural ones, 807 economic localities and 919 thousand 989 blocks in which at least one establishment is located. Regarding the georeference of the businesses in the cartography, the information of geographic location or geographic address is complemented with the geostatistical key until block level; likewise, the geographic coordinates (latitude and longitude) are provided that allow the approximate location of the businesses in the geostatistical mapping.

The Directory is continuously updated by authorized informants, who can update or supplement their business data and incorporate commercial information online using the application found in the technical data sheet of each economic unit. This information is validated previously by INEGI. Also available are free download of the entire Directory or only the specific information that the user selects, as well as the query from mobile devices—such as cell phones or tablets—, as well as in the Digital Map of Mexico.

¹⁵ National Statistical Directory of Economic Units, published on the official INEGI portal <http://www.beta.inegi.org.mx/app/mapa/denue/>

5. Global Statistical Geospatial Framework (GSGF)

5.1 Conceptualization ¹⁶

The international community has recognized the challenge of better integration of geospatial and statistical information and has endorsed the United Nations - Experts Group on the Integration of Statistical and Geospatial Information (EG-ISGI) to develop a Global Statistical Geospatial Framework (GSGF), which was approved at the sixth annual meeting of the United Nations - Committee of Experts on the Global Geospatial Information Management (GGIM) and endorsed by the 48th United Nations Statistical Commission in March 2017.

The GSGF provides the international community with a common approach to connecting people-centered information (socio-economic and environmental statistics) to a location and improves the accessibility and usability of these geospatial-enabled statistics. It also provides an important communication tool and a common platform for the international community to discuss and understand the requirements of geospatial capabilities for statistical information. This has been a vital element on the road to the integration of geospatial capacity in statistical transformation and modernization efforts and in development efforts in national statistical systems. It has also provided the mechanism for connecting statistical information to efforts to improve the management of geospatial information at the global, regional and national levels.

The GSGF is a high-level framework consisting of five principles that are defined through a set of goals and objectives and supported by applicable national and international standards and good practices; Are also considered principles essential to integrate geospatial and statistical information:

- Principle 1: Use of a fundamental geospatial infrastructure and geocoding
- Principle 2: Geocoded data records within a data management environment
- Principle 3: Common geographies for the dissemination of statistics
- Principle 4: Interoperable data and metadata standards
- Principle 5: Accessible statistics and geospatial usable

¹⁶ Background Document on Proposal for a Global Statistical Geospatial Framework, UN-GGIM, 2016

5.2 Alignment of Mexico and the National Geostatistical Framework to the GSGF Principles ¹⁷

Because of the breadth of the GSGF principles, they can be adapted to local circumstances, while encouraging the use of international standards and methods. The following describes how Mexico and the MGN maintains its consistency with the five guiding principles for the construction of the Global Framework promoted by UN-GGIM:

- Principle 1: Use of a fundamental geospatial infrastructure and geocoding
 - By law INEGI is the authoritative source of geospatial data and coordinator of Mexico's SDI.
 - It has the Technical Standard on Geographical Domiciles, as well as the Single Catalog of Keys of Federative Entities, Municipalities and Localities, that guarantee the interoperability using addresses and location data in administrative processes.

- Principle 2: Geocoded data records within a data management environment
 - The MGN has been adopted at different levels of government and is composed of different levels of disaggregation for the geocoding of statistical data.
The Federal Law of Transparency and Access to Governmental Public Information guarantees confidential and personal data.
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- Principle 3: Common geographies for the dissemination of statistics
 - The Technical Standard of the National Geodetic System published in 2010 guarantees the correspondence between geographies.
 - All statistical information is linked to the MGN.
 - INEGI uses agreements for the collection, processing, use and publication of information.

- Principle 4: Interoperable data and metadata standards
 - INEGI uses ISO-based metadata standards for the development of Technical Normativity to generate statistical and geographical metadata.

- Principle 5: Accessible statistics and geospatial usable
 - The Technical Standard is available for access and publication of Open Data of Statistical Information and Geographic Information of National Interest.
 - Through WMS, WMTS and other standards, INEGI disseminates Statistical and Geographic Information.

¹⁷ Template: Global Statistical Geospatial Framework principles, UN-GGIM, 2016

Conclusions

The Geostatistical Framework allows the statistical information to be related to the corresponding geographic space, divides the national territory into areas of easy identification in the field and is suitable for information gathering activities. It has evolved since its inception in 1978 and has now reached its basic objectives: to be a unique instrument of national character, whose graphic expression, geostatistical mapping, guarantees the coverage and geographic reference of statistical information.

For the first time in the history of geostatistical mapping in Mexico, a number of cartographic products have been developed at the national level by automated methods in the scale and with the information required for each project of the National Censuses. The usefulness of the Geospatial Framework and the cartography derived from it has transcended the census area and has become a unique and homogenous consultation tool at the national level for the public, private and social sectors.

The Geostatistical Framework of Mexico has been applied in our country in the last 36 years, being part of the information infrastructure of the National Information Subsystems and that complies with the five guiding principles for the construction of the Global Framework.

The use of integrated geographic and statistical data allows better design and evaluation of public policies as well as faster and more accurate decision making during disaster management situations. This has been highlighted in the discussions on the United Nations' sustainable development agenda in 2030 and is becoming a model to be followed throughout the world in the design of indicators for the Sustainable Development Goals.

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