

GEODESY AS A FUNDAMENTAL DATA SET IN THE MEXICAN SDI (IDEMEX)

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INTRODUCTION

- ▶ Geodetic Information is a fundamental data (FD) set in the Spatial Data Infrastructure of Mexico, IDEMEX
- ▶ (FD) data is a reality in a geospatial information environment, FD is the core, the common denominator of all geospatial information sets.
- ▶ Geodesy provides the main frame and a common system to reference geographic data, providing the means for connecting all geographic features to common, nationally used horizontal and vertical coordinate systems.

A BRIEF HISTORIC ACCOUNT.

- ▶ Geodesy in Mexico mainly used to aid in the elaboration of cartography
- ▶ 1769. The Military Engineers of the former New Spain. First topographic surveys in Mexico. Mining activities among the most important based on surveying and cartography.
- ▶ 1822. A Commission established to elaborate the first General Map of Mexico
- ▶ 1839 the Mexican Society of Geography and Statistics, an institution still living, compiled a Geographic Chart of Mexico.

A BRIEF HISTORIC ACCOUNT.

- ▶ 1877. Geographic Exploration Commission created to develop a new General Map of Mexico. Positioning methods based on geodetic triangulation.
- ▶ During the life of the Commission the Mexican part of the measurement of the 98° West longitude meridian going up to Canada was measured.
- ▶ 1899. Establishment of the Geodetic Mexican Commission. Made the first gravity surveys in 1912 .

20TH. CENTURY

- ▶ 1913. Agreement to unify geodetic systems in North America signed by the revolutionary Mexican government with the U.S.A and Canada. Mexico adopted the NAD27 Datum, And the Clarke 1866 Ellipsoid. These were in use for almost the rest of the Century.
- ▶ After this and up to 1968 several short lived cartographic organizations were created.
- ▶ October 1968. The Commission of Studies for the National Territory (CETENAL) was created, forerunner of the actual Directorate of Geography at INEGI (DGG), the official organization dealing with geographic information at the national level.

THE IDEMEX

- ▶ Growing influence of geospatial information increased the demands for opportune, congruent, of quality, accessible and shared information useful for everybody.
- ▶ The Statistical and Geographic Information Law regulates the national information in these matters.
- ▶ Defines as the main objective the integration and development of the National Geographic Information System (SNIG) and along with this, the idea of the National Spatial Data Infrastructure of Mexico, IDEMEX.

THE IDEMEX

Steps taken contributing to the IDEMEX:

- ▶ Continuous production of geographic information,
- ▶ Concepts development on fundamental data, metadata generation,
- ▶ Establishment and operation of Clearinghouse,
- ▶ Program on generation and updating of geospatial standards,
- ▶ Building of alliances and links to other national, regional and worldwide organizations.

FUNDAMENTAL DATA

Categories of Fundamental Data within the IDEMEX :

- ▶ Group on geodetic references,
- ▶ Group on aerial photography and satellite imagery,
- ▶ Group on data about relief,
- ▶ Group on Hydrographic nets,
- ▶ Group on communications and planimetric features
- ▶ Group on international, state and municipal, including coastal boundaries,
- ▶ Group on Cadastral data,
- ▶ Group on Geographic Names data.

GEODESY IN THE IDEMEX

- ▶ Geodesy holds the first position within FD, recognizing its most important role in the development of geospatial information as the means to geographically reference any feature.
- ▶ This is most congruent with the notion of Geospatial Data as any data characterized for having a place in the space and described by a set of attributes. The first part of this definition is only possible through subjecting geospatial data to a geodetic positioning process

GEODESY AT INEGI

Geodetic activities at INEGI are performed through three types of surveys comprising the whole spectrum of geodesy, namely:

- ▶ Horizontal surveys
- ▶ Vertical surveys,
- ▶ Gravity surveys

HORIZONTAL SURVEYS

These surveys developed through 2 stages:

- ▶ A First stage beginning 1968, characterized by geodetic surveys using traditional equipment and former geodetic surveying techniques.
- ▶ A second stage, characterized up to these times by use of GPS technology, which began by observing some points of the former geodetic net for comparison purposes and later on by establishing some new stations to initiate the establishment of the new geodetic nets

RECENT DEVELOPMENTS

PURPOSE OF H. SURVEYS

- ▶ Airborne GPS,
- ▶ Support to LIDAR surveys,
- ▶ Topographic and cadastre mapping support,
- ▶ Horizontal positioning of bench marks
- ▶ Development of baselines for Economical Exclusive Zone delimitation,
- ▶ Support to international boundaries delimitations
- ▶ Urban positioning surveys,
- ▶ Surveys to increase density of stations,
- ▶ Information and services to users.

VERTICAL SURVEYS

Main objective: to establish, increase coverage and maintain the national first order and lower orders geodetic vertical net to support the development of the several topographic and mapping projects, special national projects, help determine a geoidal model and to provide with information on heights to users requiring it.

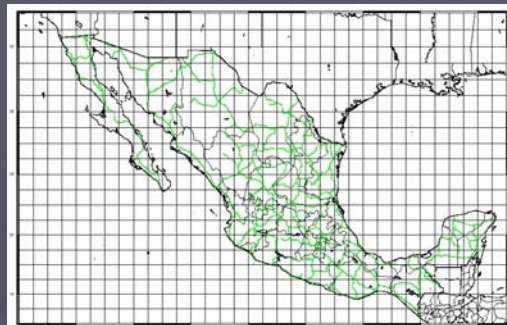
STAGES OF VERTICAL SURVEYS

First stage: Geodetic leveling started in 1950 through a collaborative effort from the Military Cartographic Department and the Interamerican Geodetic Survey (IAGS) to do high precision leveling along the country and afterwards through an agreement between the IAGS and the National University of Mexico.

STAGES OF VERTICAL SURVEYS

- ▶ Second stage: began with CETENAL when control of first order leveling was assumed, operating at this time through DGG at INEGI. At the present time the net has more than 38,000 bench marks.
- ▶ A view of the geodetic leveling net in Mexico can be appreciated in the next slide.

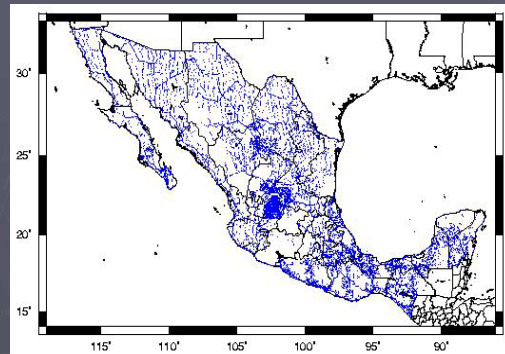
THE MEXICAN GEODETIC VERTICAL NET



GRAVITY SURVEYS

- ▶ DGG began making gravity measurements in the 80's. The objective was to develop the Gravity Mexican Net with the main purpose of providing data to support the development of the Geoid.
- ▶ The next slide shows the density of gravity coverage in Mexico to date, with more than 42,000 measured marks.
- ▶ Any point belonging to a gravity survey must be referred to the Gravity International Standardization Net of 1971 (IGSN71).

GRAVITY DATA DENSITY COVERAGE



A NEW GEODETIC REFERENCE SYSTEM

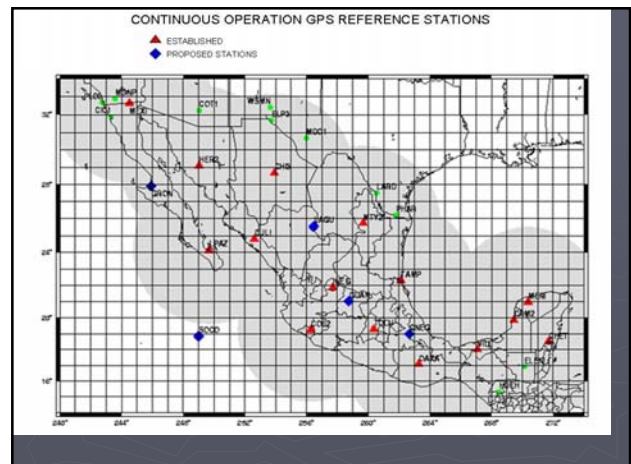
- ▶ Beginning the 90's the necessity was detected to establish a new geodetic reference system better than the NAD27.
- ▶ It was decided that the best option for Mexico was to adopt the ITRF as the new Geodetic Reference Frame.
- ▶ Decision taken to change to the ITRF92, Epoch 1988.0 in the GRS80 as the Official Geodetic Reference Datum for Mexico.

A NEW GEODETIC REFERENCE SYSTEM

- ▶ Recently a new change developed to go to the ITRF2000, epoch 2004.0, taking into consideration the now more close compatibility of the WGS84 with this new approach and the fact that from the practical, cartographic, point of view, no significant differences will arise regarding the former ITRF92.
- ▶ The above is also compatible with the SIRGAS project (Geocentric Reference System for the Americas) to which Mexico belongs.

THE NATIONAL ACTIVE GEODETIC NET (RGNA)

- ▶ Closely connected with the new Reference System a new geodetic horizontal net was established through the National Active Geodetic Net and the corresponding passive net.
- ▶ The RGNA is a set of 15 fixed and permanently operating GPS stations distributed along the country (next slide),



CHARACTERISTICS

- ▶ Stations established in the 5 cm. accuracy positional standard,
- ▶ Located so any point in the country is covered by at least two stations,
- ▶ The stations register permanently the information transmitted by the NAVSTAR constellation integrating the space sector of the Global Positioning System.
- ▶ Products of the RGNA are files with observations for each station, giving the coordinates in the adopted reference system, latitude, longitude and ellipsoidal height.

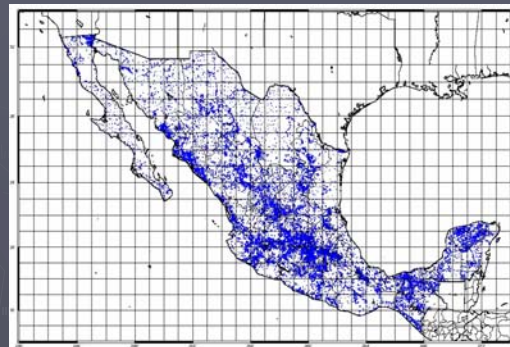
PURPOSE AND USES

- ▶ Stations are fiducial and monitoring stations
- ▶ Registry of changes associated to the reference system,
- ▶ Basis for the development of the National Passive Geodetic Net,
- ▶ Support to users which need to reference their surveys to the National Geodetic System.
- ▶ The RGNA is the national fundamental reference frame for all geodetic positioning surveys performed along the country.
- ▶ Supposed to grow in number as other agencies establish permanent stations and agree to integrate (there is one already).

THE NATIONAL PASSIVE GEODETIC NET (RGNP)

- ▶ The National Passive Geodetic Net is composed by more than 53,000 (next slide) points distributed all over the national territory with the common denomination of "GPS points".
- ▶ All of these are physical marks. The horizontal coordinates defining the position of each station were generated through GPS measurements linked to the RGNA,

DENSITY OF THE MEXICAN GEODETIC PASSIVE NET



GEODETIC STANDARDS

- ▶ A key component of the IDEMEX
- ▶ 1985: Minimal Standards Frame for Geodetic Surveys.
- ▶ Covered prevailing technology.
- ▶ Included numerical specs and basic procedures.
- ▶ Standard for all Federal government agencies.
- ▶ In force up to 1998.
- ▶ 2003. A new normative Program, PRODENOR
- ▶ 2 New normative documents: National Geodetic System and Positional Accuracy Standards

THE NATIONAL GEODETIC SYSTEM STANDARD

- ▶ Defines the three modes of geodetic surveys
- ▶ Establishes GRS80 as the reference Ellipsoid and gives its parameters
- ▶ Defines the Horizontal Geodetic System and Establishes the ITRF2000, epoch 2004.0 as the official national reference frame.
- ▶ Defines both the RGNA and the RGNP
- ▶ Establishes the basic standards for Vertical and Gravity systems

THE POSITIONAL ACCURACY STANDARDS

- ▶ Purpose: to establish the orders of positional accuracy to be observed for any geographic referencing work.
- ▶ References on instrumentation and procedures to attain the standards are not included. Idea is to norm on the “what” and not on the “how”.
- ▶ Specifies the different orders of accuracy for horizontal surveys to be evaluated through the Circle of Probable Error in the 95% confidence level,
- ▶ Go from the most accurate order of 1 cm. up to an order of 500 m, along with would be applications. Includes standards for leveling

GEODETIC INFORMATION SERVICES

- ▶ Information about the three geodetic nets has been available to other agencies and the general public through a geodetic data bank
- ▶ The IDEMEX requires a policy to grant access and provide for dissemination and proper distribution of geographic information
- ▶ 2003: Directive issued to put all geodetic information in the website of INEGI, at no cost to any user and without any strings attached
- ▶ This establishes a formal connection between geodetic information and the IDEMEX.

CONCLUSION

INEGI is working towards a rationalization of geodetic data and information closely connected to the IDEMEX, reaffirming its character as a fundamental data set which has permitted as a principal outcome in Mexico the total national topographic mapping coverage at the 1:50,000 scale and now to support the new project of topographic mapping at the 1:20K scale. Geodetic data is available and accessible to all users at no cost, favoring with this approach the sharing of information, one of the main objectives of the IDEMEX