Contribution of GIS for the Geodetic Network Management

Aicha DERKAOUI, Boualem GHEZALI, and Bachir GOURINE, Algeria

SUMMARY

The geodesy techniques (terrestrial or space) require a variety and a significant volume of data (observations, geodetic repertories of points, satellites ephemerid, data geodetic, etc). Compared to the traditional research method based primarily on the consultation of the archives and deprived of any computing tools, the geographical information system (GIS) tools offers a gain in cost and access time to the data, and allows a more effective orientation of manner of the operations of realization of the specific geodetic networks.

One proposes by our participation to present work which consists of the design and the realization of a geographical information system of the state of the various geodetic networks. The user of this system has functionalities of space and semantic interrogation allowing us to answer any request aiming at getting informed about the existence of an unspecified geodetic data on an area.

The realization of this GIS required an inventory and an analysis of existing which made it possible to classify the data in four fields (gravimetric network, levelling network, terrestrial geodetic network and geodetic network space GPS). The development of the conceptual diagrams by field allowed the implementation of the descriptive part under the DBMS "Access". The passage of the semantic tables towards the diagram is carried out, under the environment "Mapinfo", by the creation of charts of the various networks, while connecting graphic information to these semantic attributes in the base. Finally, the semantic and space diversified rules of interrogation are assured by interfaces, developed in language "Mapbasic", adapted well to the needs for the users of geodetic information.

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1 INTRODUCTION

The topic developed through this article relates to the conception, the realization and the setting up at CTS of a geographical information system (GIS) of various geodetic networks state. The user of this system has functionalities of space and semantic interrogation allowing to answer any request aiming at getting informed about the existence of an unspecified geodetic data on any region.

This work realized at the division of geodesy in the CTS, consists in the implementation of a GIS of the geodetic networks state which comprises two large shutters:

1st shutter: **data Base**

The data base design has required the development of several phases:
- Inventory of geodetic information by field while being based on documentation available to the level of CTS: it comprises the description of the data, the compilation of the specifications documents of the producers of geographical information, and collects it and the exploitation of the existing data. The data were classified in four fields (gravimetric network, levelling net, terrestrial geodetic network and geodetic network space GPS)
- Modelling of geodetic information by field: it makes it possible to release the framework of the geodetic network, notably in term of specification, description of information which will be supported by the system. This phase will be represented by the establishment of a conceptual diagram per field using the approach entity association and formalism HBDS by integrating all the descriptive and functional constraints.
- Implementation of conceptual diagram of each field under the relational DBMS "**Access** ".
- Validation of geodetic data base.

2nd shutter: **GIS Model**
Once the formal definitions of adopted information, a model SIG is developed under software SIG "**MapInfo** ".It includes especially the space constraints of the data.
So, to give the required to place at the disposal of the users of geodetic information, a convivial system, in which the tools used are transparent for the user, of the diversified rules of interrogation semantic and space were developed in language "**Mapbasic»** under the environment "MapInfo". They play the role of interface with the users of geodetic information, and will allow a saving of time of access to the unspecified geodetic data on an area.

2 DATA BASE

2.1. Geodetic information Analyzes

Within the framework of this work, this step consisted to inventory and analyzes the existing geodetic data at the Centre of the Space Techniques (CTS).The exploitation of the various documents and files existing and the needs study of the various users of geodetic information, that they are researchers or economic operators, public or private, enabled us to draw up a list of classified data in four fields:

***Field "gravimetric network"*:** the gravimetric network is mainly subdivided in three partial networks (orders 0, 1et 2).A gravimetric point is described by descriptive and geometrical information (number, designation, order, nature, type, state, type of observation, measuring instrument, gravity observed, geodetic system, anomaly with the free air, correction of ground, geographical position and its precision, altitude system, altitude and precision, method of treatments, etc).

The gravimetric data used were provided by the International Gravimetric Office (B.G.I.) and are expressed in the Geodetic Frame of reference GRS80.The precision a priori of measurements is 5 mGals.

Field "traditional geodetic network": the traditional network of geodesy is established by terrestrial techniques (measurements of angles, distances and azimuths) and is calculated on an ellipsoid starting from a fundamental point [Bouteloup.D, 2002].The geodetic points are materialized on the ground by reference marks that's their co-ordinates are published in the form of repertory. This field gathers information relating to the observations (period, said place, operator, instruments, type of measurement, precision, etc.) and with the geodetic treatments (method of calculation, dates, material, ellipsoidal, cartographic projection, precision, etc), and with the description of the geodetic points (number, cartographic and administrative situation, geodetic system, order, co-ordinates geodetic, system of altitude, altitude, precision, repertory, etc).

The exploited data are provided by the INCT (National Institute of Cartography), as a national organization having charges of it the national geodetic network and the basic cartography.
Field "levelling net": a bench mark is represented by descriptive and geometrical information (number, name, state, type, nature, number and name of the advance, cartographic and administrative situation, kilometric point, determination technique, responsible organization, repertory, altitude system, altitude, precision, etc.) [B chemaa, 1999]. Other information relating to the observations is integrated into knowing the points of reference concerned, the time and the session of observations, measurements, the instrument used the name of the operator, etc.

This field gathers also the "network of GPS/levelling" which represents levelled stations GPS which are attached to the Algerian General levelling network (NGA).

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Field "network of space geodesy": the network of space geodesy is carried out by space observations techniques (GPS, space Altimetry, DORIS, VLBI, etc).Within the framework of this work, the data of space geodesy used result from technique GPS.A point GPS is described by information relating to the observations (number of the point, cartographic and administrative situation, period, name of the session, hour beginning and end of the session, said place, operator, instruments, type of measurement, height of the antenna, numbers satellites observed, etc.) and with the treatments (software, method of calculation, date, network of reference, geodetic system, geodetic co-ordinates, system of altitude, altitude, precision, etc). [N Dennouni, 2004]

2.2. Data Modelling

Modelling constitutes a step of investigation making possible to manage a network. It is a fundamental step in the data base design.

The method adopted for creation of these models is MERISE (Method of Study and Data-processing Realization of System of Company) which envisage a design by levels which are as follows [H. Tradieu & A. Rochfeld, 1991]:

The conceptual level: Conceptual model of Data (CDM).The reference diagrams models used in this level are the model "Entity Association" and model "HBDS" (Hypergraph Based Data Structure) [F Duquenne, 1990].

The logical level: Logical model of Data (LDM).This level introduces the notion of the logical tables, and thus constitutes the first step towards the tables of the relational DBMS.

The physical level: Physical model of Data (PDM).It is based on the logical model of the data and contains finally the tables using a DBMS.

2.3. Implementation
It is a question on this level of translating the CDM into a relational model nearer to the machine.

After standardization and transformation of the CDM into relational logical model, an implementation by field was carried out under the relational DBMS "**Access** ".The validation of the various physical models established for each field is based on concrete data available at the CTS.

3.   GIS MODEL

In addition to the functionalities which the DBMS offers, the GIS offer particularly development tools, of statistical processing, superposition operations and space analysis. They also make possible to express and carry out complex queries, and to import data starting from other systems (SIG and DBMS) and of image processing software.

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3.1. Creation of the graphics cards

The approach adopted for the creation of the networks graphics boards under the environment "MapInfo" is as follows:

- − A.   Connection to the data base of "Access" via the tool ̤ connection DBMS ̤ ;
- − B.   Importation of the tables;
- − C.   Creation of Linkage enters the tables using requests SQL [Viescas J.];
- − D.   Creation of the chart of the points (geodetic, gravimetric, etc).

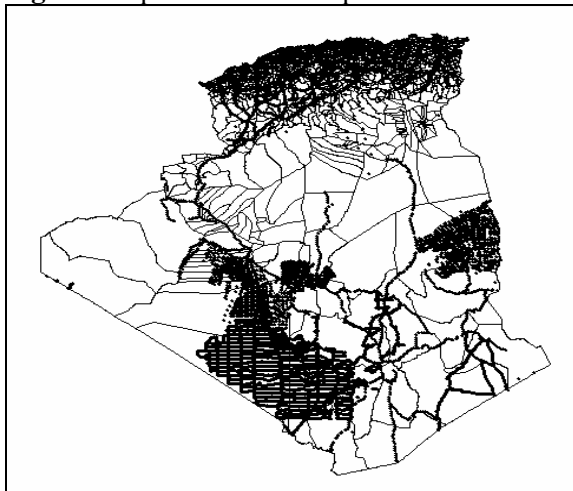**Figure 1** represents an example of the distribution of the national gravimetric network.

Figure 1: distribution of the gravimetric points.

Tool SIG also makes possible to cross semantic criteria; the following figure (2) illustrates an example of this crossing of criteria:
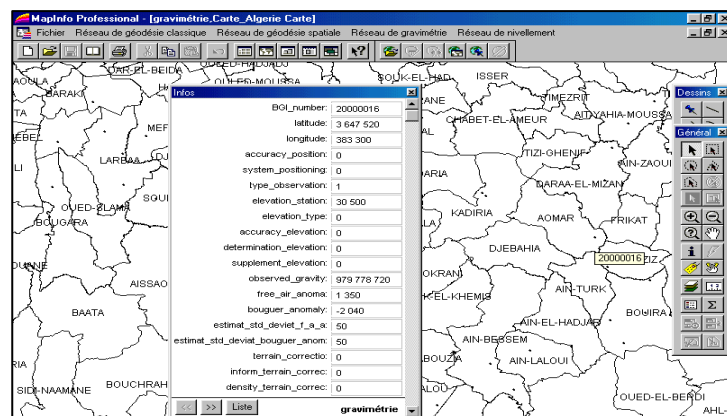

Figure 2: localization and consultation of a gravimetric point.

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3.2. Development of the personalized menu

To concretize our work, we developed, in language MAPBASIC, a program giving easy access to information, the fast and convivial communication between the user and the software and the fast execution of queries personalized by simple clicks.

The developed interface consists of a menu composed of five submenus related to distinct separate and executable applications.Figure (3) illustrates the principal functionalities of the principal menu:
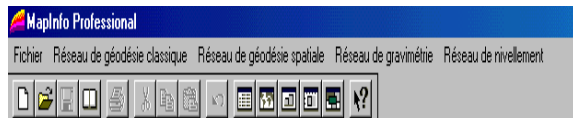

Figure 3: The main menu of the program.

The menu "fichier" (file) regroups the principal functions of the menu of MapInfo such as the importation of table and the modification of the table structure (figure 4).
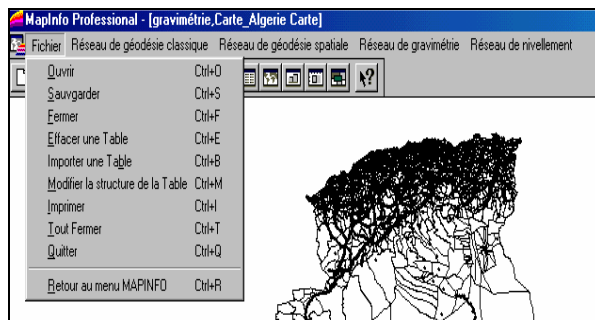

Figure 4: Description of menu " Fichier (file)".

An example of menu "réseau de géodésie classique" (terrestrial geodetic network) is illustrated by figure 5.It allows the visualization of the points of the network on a chart and the execution of some space and semantic requests.
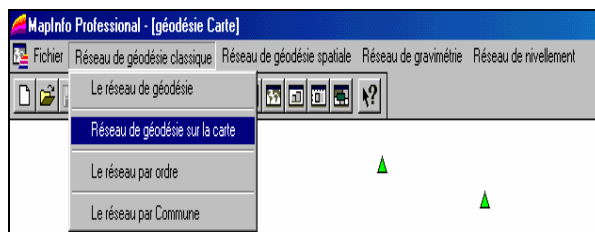
Figure 5: menu "terrestrial geodetic network "

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3.3. Mechanisms of interrogation

The GIS get at the same time simple tools of interrogation and powerful solutions of analyses.The integration of data through various layers of information makes it possible to carry out a rigorous space analysis. This analysis by crossing of information, if it can be carried out visually often requires the crossing of semantic and graphic information. The following figures (6) and (7) illustrate some examples of interrogations:
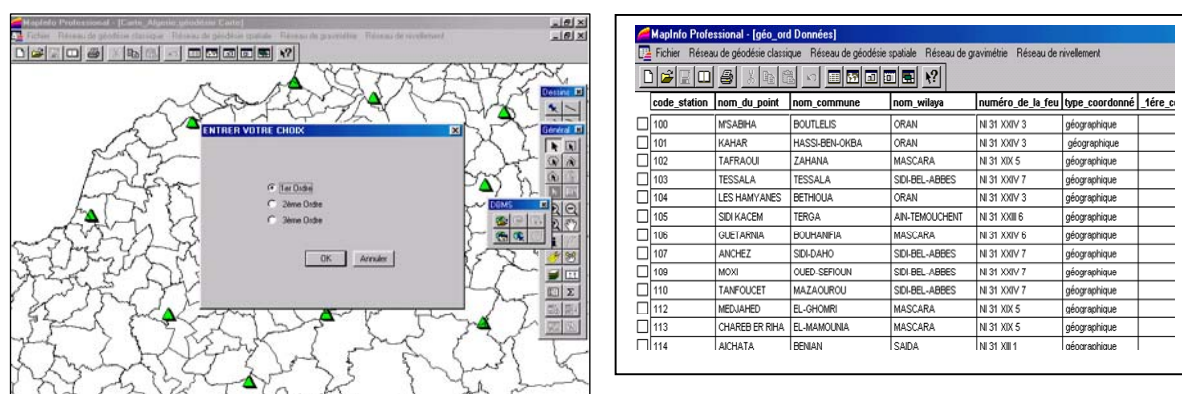

Figure 6: selection of geodetic points by order

Figure 7: Selection by name of commune

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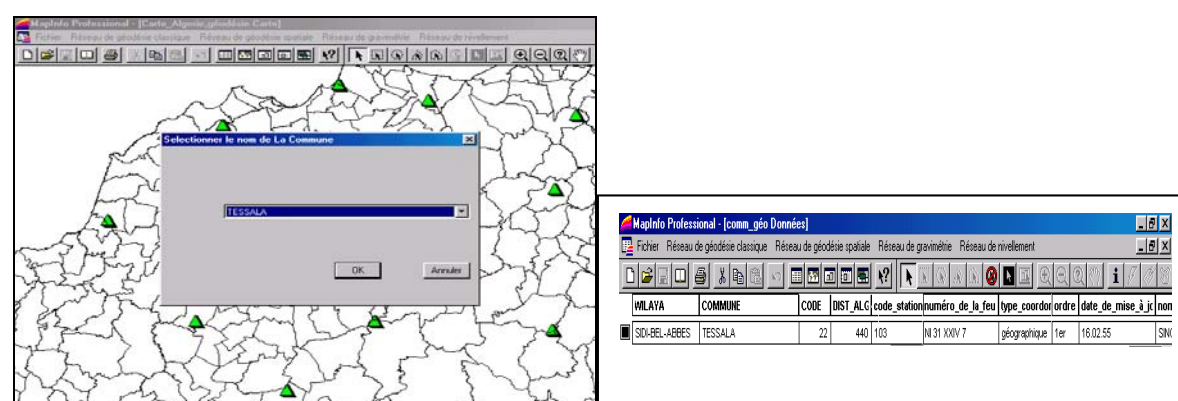
4. CONCLUSION

The work presented in this article constitutes a chain link of the geographical information system development intended to place at the disposal of the various actors interested by the geographical Information of a state information tool of country cartographic cover, integrated in a consultation process via a communication network (national network, Internet, etc).This system once operational, will as well have positive repercussions from the economic point, scientist and technique. Indeed, it will constitute a major tool for promotion of the use of geodetic information. In the same way, it will make possible to develop existing information and to direct in a more efficient way the programs of realization of cartographic covers. This will generate consequently an appreciable profit in cost and access time to geodetic information. The system must have all the functionalities of interrogation and formulation of requests while being based on administrative cutting or the specification of a particular area. It will have to give to the users of geodetic information, a convivial system, in which the tools used are transparent.

The developed application, within the framework of this work, clearly proves the feasibility of such project. It will make possible to the user to equip with a powerful and updated tool of information on the states of the various geodetic networks by the means of mechanisms of space or semantic interrogation. Nevertheless, the validation of this tool was based only on one restricted sample of geodetic data available at the CTS and will not allow, consequently, pronouncing on its reliability.

In prospects, we count, in a future version, to integrate in this application new requests and space and semantic interrogations rules more efficient which take account of the characteristics of the geodetic data.

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BIOGRAPHICAL NOTES

Aicha Derkaoui, born in 1975, graduated in 1998 as Dipl-Ing. In geodetic sciences. From the center of spatial techniques of Algeria.
Research Domain: Spatial Geodesy, GIS and data warehouses, geodetic networks deformation

CONTACTS

Ms. Aicha Derkaoui
Geodetic laboratory – center of spatial techniques
Avenue of Palestine
Arzew – 31200
ALGERIA
Tel. +213 41472217
Fax. +213 41473665
Email: derkaouia@hotmail.com

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