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Data base for Timisoara City groundwater

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Abstract – At present, database management is a key role in monitoring, maintenance and exploitation of hidroedilitar resources. The paper has as starting point the request of a research contract between Hydrotechnical Faculty of Timisoara and the City Hall of Timisoara. The paper target is to illustrate the possibility of achieving a proper inventory of water resources from Timisoara.

Keywords: GIS, GPS, DBMS, Stereographic 70, ETRS89, NAVSTAR

1. INTRODUCTION.

Among other utilities, data bases are crucial element in monitoring, maintaining and exploitation of water resources, but not only.

The data base concept and creation must be made in a unitary system and according to the beneficiary demands, on this case with the Environmental Department of Timisoara City Hall.

GIS projects are mainly referring to certain territory (zone/interest area – locality, county, country etc.) collecting information (cartographic and descriptive) concerning the target area.

Prior, in a first phase of a GIS concept we must chose the GIS environment, that involve the software desired to link the application, were it must be take into consideration a series of technical specifications but also economical. For each GIS environment available on the market there are lots of particularities that can keep the system away or closer to the application demands.

The Data Department of Timisoara City Hall has at present a performing GIS of the city, an open system, ready to be updated with new data.

Spatial information management in classic format (classic maps, plans, any kind of data having spatial reference etc.) can no longer satisfy the viewing necessities of a quick and complex analyze of spatial information for different field of activities.

Geographical Information Systems are part of a large information system. Its main characteristics consist in treating the information by considering its geographical, spatial location in territory through coordinates. GIS technologies appear due to the necessities to facilitate complex operation of geographical analysis where CAD and DBMS were unable to solve problems or required too much time and laborious procedures.

The paper present the update modality of an existing GIS by using one of its 4th components, the

geographic data component. This is a determinant component being one of the most costly components of GIS. Therefore, input data is of considerable importance. Data input can be done through various ways: by digitizing, scanning, from field measurements (total stations, GPS etc.), processing the remote sensing images, digital fotogrammetry or conversion from other formats.

2. COLECTING DATA USING GPS

In order to update the existing GIS of Timisoara City Hall the GPS technologies was use. The Global Positioning System, having its complete name NAVSTAR (*NAVigation System with Time And Ranging*) consist of a space segment (the satellites), a control segment (the ground stations), and a user segment (the GPS receiver).

GPS brings a revolution in geodesy and generally speaking in positioning, being today the most precise, most reliable, most economic, the fastest way of determining the space position and the appropriate way of collecting data for GIS databases.

In our case, the receiver use for data acquisition is a MAGELLAN eXplorist 500 unit.

The eXplorist 500 uses information from the GPS satellites orbiting the earth to provide us with detailed information about our exact location, in a certain coordinate system.

Anytime we want to view the status of the satellites and their signal strength, we can switch to the Satellite Status screen where graphically the satellites and their relative signal can be see. We will need at least three satellites with good signal strength to compute our position. A computed position with only three satellites is termed a 2D position fix. When we are getting a 2D position fix, the elevation is not being computed. To add elevation to our position fix, we need at least four satellites with good signal strength. The positions that use four or more satellites are called 3D position fixes (fig. 1).

Once the unit stores data about where the satellites are located at any given time the unit build its so called almanac.

3. SOURCES OF ERRORS AMONG THE COLLECTING DATA PROCESS

GPS receivers have potential position errors due to the result of the accumulated errors due primarily to some of the following sources:

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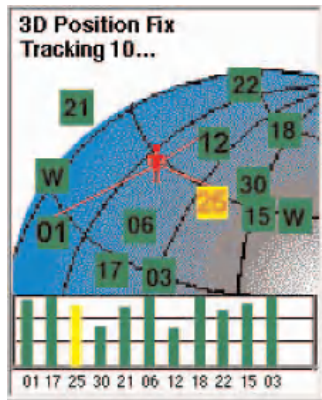


Fig.1 A 3D Position fix screens of Magellan eXplorist 500

- ionosphere and troposphere delays – the satellite signal slows as it passes through atmosphere. The system uses a built-in “model” that calculates an average, but not an exact, amount of delay;
- signal multi-path – occurs when the GPS signal is reflected off objects such as tall buildings or large rock surfaces before it reaches the receivers. This increases the travel time of the signal, thereby causing errors;
- receiver clock errors – since it is not practical to have an atomic clock in the GPS receiver, the built-in clock can have very slight timing errors;
- orbital errors – also known as “ephemeris errors”, these are inaccuracies of the satellite’s reported location;
- number of satellites visible – the more satellites the receiver can “see”, the better the accuracy. Buildings, terrain, electronic interference, or sometimes even dense foliage can block signal reception, causing position errors or possibly no position reading at all. The clearer the view, the better the reception.

Now, turning back to the paper purpose, the accuracy used to determine the position of the wells is around 1m, therefore using the Magellan eXplorist 500 unit was considered an appropriate solution.

4. COORDINATE SYSTEMS

Having by now established the field operation procedure and the device use for collecting data it is better to turn our attention on the coordinate systems used for representing the data collected.

The GPS unit has the possibility in the Map Units option of Preferences to select which units of measure for navigation, coordinate system and map datum will be used by the eXplorist.

Due to the fact that the beneficiary demands for data are in Stereographic – 70 projecting system, we need to obtain the data in such format.

The problem that appears in using the GPS unit, was that it can not be set out to collect and

compute data in the Stereographic – 70 projecting system and therefore we let the unit set to collect geographic data (latitude and longitude) using ETRS 89, European reference system.

Stereographic 1970 projection system is conformable, it does not modify the angles. However the projection deformed the areas, according to their position from the projection pole.

Computing the rectangular coordinates in Stereographic Projecting System 1970 depending from the geographical coordinates from Krasovski ellipsoid 1940 is made by using formulas with constant coefficients, related to the difference of latitude and longitude respectively, between projection pole and point represented.

As part of the procedure we distinguished two steps:

- computing the stereographic coordinates in the tangent plane, related to the geographical coordinates from the ellipsoid, the most laborious step;
- transforming the stereographic coordinates from the tangent plane in the secant plane, by affecting the scale with a subunitary coefficient.

The computing formulas are already established by a method of V.Hristov.

In our case for computing the rectangular coordinates (X,Y) according to the geographic coordinates (B,L) the software TransDatRO was used. The software allows the coordinates transformation based on the grid distortions. Schematic the transformation can be illustrated as follows:

$$(B, L)_{ETRS89} \Rightarrow [1] \Rightarrow (X, Y)_{ObliqueStereographic_GRS80} \Rightarrow [2] \Rightarrow (X', Y')_{Stereographic1970} \Rightarrow [3] \Rightarrow (X, Y)_{Stereographic1970}$$

Fig.2 Coordinates transformation

Where:

[1] – means the conversion from the ellipsoidal coordinates from ETRS89 system (GRS 80 ellipsoid) to the rectangular coordinates from the Oblique Stereographic projection on GRS80 ellipsoid;

[2] – means the Helmert transformations with 4 parameters from the rectangular coordinates obtained in the Oblique Stereographic projection on GRS80 ellipsoid to the rectangular coordinate system in Stereographic 1970 projection system.

[3] – correction interpolations (distortions) from the distortions grid, that is placed in a shape file and obtaining the final Stereographic 1970 coordinates by summing the corrections to the coordinates obtained at the previous step.

ANCPi use the following data in order to verify calibrate and testing the software

Table 1

Point	φ _ETRS 89	λ _ETRS 89	X_Stereo 70 [m]	Y_Stereo 70 [m]
1	47 42 56.40000	22 28 32.00000	693771.731	310723.518
2	47 58 33.20000	26 53 26.70000	721361.806	641283.450
3	46 03 57.40000	20 40 11.60000	516470.189	165265.572
4	45 05 18.20000	27 42 24.00000	402327.815	713143.130
5	44 26 51.30000	22 54 09.30000	329703.378	333185.413
6	43 44 37.20000	25 13 48.10000	249343.594	518651.464
7	46 14 47.60000	23 50 46.10000	528076.247	411159.899

Once this step achieved, the only problem remain to solve is to prepare the data downloaded from the GPS unit in a suitable format for TransDatRO software.

This operation is possible due to a Survey Processing Software (fig. 3), made by the authors, that convert the data downloaded from the GPS unit into data available for TransDatRO software.

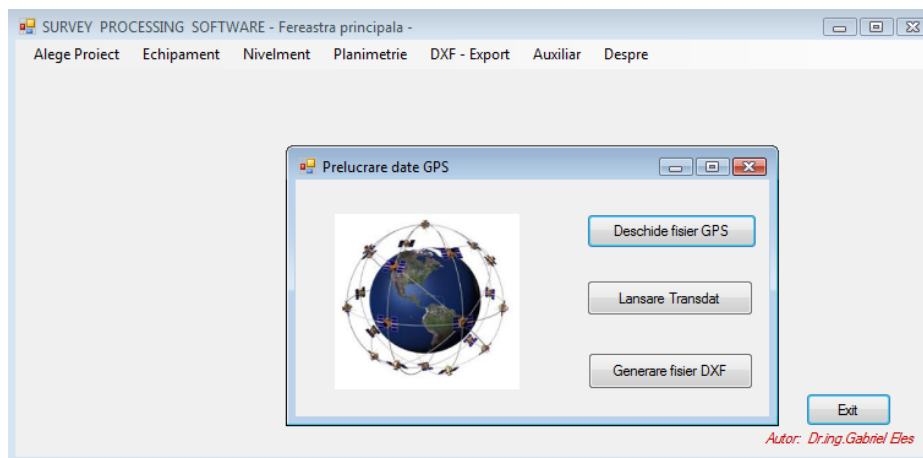


Fig. 3 Survey Processing Software

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SPMGNWPL,4545.729,N,02114.276,E,0000103,M,Foraj 106,,a*0E
SPMGNWPL,4545.468,N,02114.163,E,0000096,M,Foraj 108,,a*0C
SPMGNWPL,4545.286,N,02113.614,E,0000123,M,Foraj109,,a*1C
SPMGNWPL,4545.476,N,02113.769,E,0000096,M,Foraj P-ta Unirii,,a*31
SPMGNWPL,4544.721,N,02113.737,E,0000092,M,Foraj Camine MV,,a*25
SPMGNWPL,4544.499,N,02113.568,E,0000111,M,F BLC,,a*71
SPMGNWPL,4544.788,N,02112.987,E,0000098,M,Foraj P-ta Sinaia,,a*48
SPMGNWPL,4545.597,N,02113.946,E,0000096,M,Foraj Popa Sapca,,a*54
SPMGNCMD,END*3D

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Fig. 4 Sample of data downloaded from the GPS unit

In order to acquire data with Magellan eXplorist 500 GPS device, the unit was place over each well and after gathering the geographic coordinates of the well the data was stored into the internal memory of the unit. After collecting the whole data, the geographic coordinates were downloaded from the unit into the computer into an ASCII file format (fig. 4).

The following step consist in running the application named Survey Processing Software, which this time is working as an interface between the

data downloaded from GPS unit and TransDatRo software, in the meaning of preparing the input data for TransDatRo software. After lunch and running the TransDatRo software the out coming data are the points coordinates in Stereographic 70 projecting system.

The final step of the Programming-Survey consist in generating the DXF containing the points coordinates in Stereographic 70 projecting system ready to be use by any kind of CAD systems.

Project:C:\Users\Gabriel Eles\Documents\Visual Studio\2005\Projects\David&Eles\David&Eles\bin\Debug\
Default POI File.txt

```
1, 480497.914, 207580.999, fara_cota, +/- 0.018, +/- 0.024
2, 480021.738, 207411.804, fara_cota, +/- 0.018, +/- 0.024
3, 479718.491, 206684.584, fara_cota, +/- 0.018, +/- 0.024
4, 480060.662, 206902.040, fara_cota, +/- 0.018, +/- 0.024
5, 478665.197, 206794.497, fara_cota, +/- 0.018, +/- 0.024
6, 478264.660, 206556.048, fara_cota, +/- 0.018, +/- 0.024
7, 478835.243, 205828.471, fara_cota, +/- 0.018, +/- 0.024
8, 480273.781, 207141.942, fara_cota, +/- 0.018, +/- 0.024
ENDF
```

Fig. 5 Sample of data generated by TransDatRO

5. CONCLUSIONS

Using GPS devices in order to achieve the points coordinate of stationable points is mostly efficient.

The time necessary for data acquisition is very short and involves short periods of time that leads to a high working efficiency.

If we are turning our sight, to other methods of determining the points coordinates, such as topographical intersections, we find that this procedure did not request additional points of knowing coordinates.

Also the method no longer needs to buy data from ROMPOS®.

However it necessary to mention that knowledge concerning geodesy, cartography data processing and programming are imperative necessary.

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