

STUDY ON THE DEVELOPMENT OF A GIS FOR IMPROVING THE MANAGEMENT OF WATER NETWORK FOR AN AGRICULTURAL COMPANY

Jenica CĂLINA, Aurel CĂLINA

University of Craiova, Faculty of Agronomy, 19 Libertatii Street, Craiova, Romania,
E-mails: jeni_calina@yahoo.com, aurelcalina@yahoo.com

Corresponding author: aurelcalina@yahoo.com

Abstract

This paper presents in a rigorous and practical manner the way of developing and implementing a GIS, in which surveyed data is processed and the final results that contribute to the analysis and solving issues that arise on a day, to day basis, in the uninterrupted process of using a drinking water supply network, in order to improve its efficiency and the quality of the services. Using GIS software, maps and other cartographic data can be introduced into the system. Afterwards, the data can be stored for long periods of time, accessed at any point and easily analysed. With the tools made available by the GIS software, the datasets can be processed and new relevant information can be extracted which can be designed and printed as new maps. Such a system is truly a transformative ensemble of software because it has the power of changing the way decisions are made in a agricultural company, or anywhere in the world. In the field of hydraulics where it shall be used, it has been proven that the use of a GIS allows for a better and more detailed understanding of the water network and the way various network elements interact with each other. For an improved management of the water network, it is possible to also add to the database details regarding the quality and quantity of delivered water in a certain region. This makes merging all of the information in one system very important. All this precise information will improve the efficiency from a technical standpoint and also from an administrative one which will result in higher quality services for the customers

Key words: water management, coordinates, database, GIS, inventory, map

INTRODUCTION

As it is known, the GIS acronym – Geographical Information System, is frequently used in relation to computerised technologies whom are geographically oriented, integrated systems for various applications in the field and lately, for a new discipline that is generating worldwide a high degree of interest. Geographical information systems are often characterised by flexibility and diversity. GIS is an integrated system that brings together ideas developed in many fields such as: agriculture, botany, economics, mathematics, photogrammetry, zoology, geography, remote sensing and many others [4, 10].

Depending on the tasks that it needs to fulfil, there can be identified two types of information systems: 1. Transaction processing systems; 2. Decision support systems.

In the transaction processing systems, the accent is put on the recording and management of new operations. Banking transactions and plane ticket reservations are two ideal examples. These systems no matter if they work online or in a batch data processing mode can be oriented towards interrogating and refreshing data and there are some very well defined procedures [7].

In the decision support systems, the accent is put on processing, analysis and data modelling with the sole purpose of aiding decision-making. In a GIS, the reality is represented with the help of well defined graphical elements that can be put into two categories. Geographical data is used with the purpose of defining a position for the statistical data, such as administrative boundaries, a network of rivers or the coordinates of a point on top of a hill [1].

In a GIS, the geographical component is considered to be more important than the statistical one, and this is one of the main

differentiating factors that sets it apart from other information systems. The terms “spatial” and “geographical” are often used interchangeably to describe geographical elements. The term “spatial” refers to any kind of information that can be tied to a particular location and it can include data gathered via remote sensing or topographical survey. The term “geographical” refers only to information regarding the position on the surface of the Earth or in its immediate vicinity [14].

The relationship between GIS, CAD, computerised cartography, database management and remote sensing is important for establishing a definition for GIS. It is sometimes considered that a GIS is a subset or a superset of the aforementioned systems. Not all programs that are capable to graphically represent a series of geographical elements can be considered a GIS [18].

Computerised cartographic systems are focused on interrogating and extracting data, classification and automatic symbology allocation. The focus is on graphically representing elements and not on using them in an analysis. These systems use simple data structures [22]. These can be correlated with database management systems but only basic database interrogation operations can be made. Computerised cartographic systems benefit from an array of tools with whom high quality vector maps can be designed and rendered [19].

Various notions regarding the geographical system can be reduced to just three components: the map, the database and the spatial analysis tools. The evolution of a GIS can be described as a process that contains three phases. The systems that are in the initial development phase are strongly oriented towards collecting and managing the data inventory. After three to five years, the focus shifts towards analysis operations. Most of the systems reach maturity after another 3-5 years and only afterwards can be considered to be decision support systems. Only in this final phase the spatial analysis operations and modelling start being routine [8].

According to ESRI, a GIS is a framework for collecting, managing and analysing data.

Rooted in geography, GIS has the capacity to integrate an array of data. It analyses positions and organises multiple layers of information that can be visualized and represented with the help of maps and 3D modelling. With these unique abilities, GIS has the capacity to discover the relationship between data such as patterns and situations, helping its users to make wiser decisions [6].

MATERIALS AND METHODS

In this paper are presented fundamental elements of a GIS, the topographical and geodesic notions necessary, the implementation and development of a GIS in the field of water collection and distribution and the way in which it incorporates a vast array of data and information, how it stores it, analyses it and renders plans, maps and spatial analyses that assist in decision making, water network development and quality increase of rendered services.

Full implementation requires careful planning and management. Good knowledge and understanding of each of the system's components is critical for planning the development and implementation strategy. Organisational GIS include the integration of a wide spectrum of technologies. There is a wide array of hardware manufacturers and solutions for network storage, database servers, Web servers, geographical data visualisation servers and desktops, all connected into various configurations either in local networks or straight to the internet. All these technologies must be able to function with one another in order to maintain a balanced processing environment [5, 21].

Centralised systems with a single database are the easiest to implement and maintain. Obviously, the ones with multiple databases are more difficult to implement and maintain. Because of this fact, many small and medium sized organisations decide to choose the former option, such as the one that was implemented in this study, for whom the risks of failure are smaller [23].

There are many opinions, steps and strategies for implementing an IT project and for the development of a GIS, but in this study were

used the following guiding strategic initiatives:

1. Developing and implementing a strategy – A strategic plan is the guide that must be followed through in order to establish what is the initial vision, the objectives, requirements and other parameters associated with the implementation of a organisational GIS [16, 21].

2. Initiating a pilot phase – Considering the investment required for an organisational GIS and the extended period of time associated with full implementation, a pilot phase is an excellent opportunity for producing tangible results and for improving the project's support [15].

3. Establishing the hardware architecture and the software environment – The foundation of a GIS is given by the design of the hardware structure and the suite of software that need to produce the necessary results for the first phase. This will be different from one company to another because of the different requirements and needs [13, 21].

4. The development of a basemap – The main layer on which the system is built is the map of the area in which it needs to perform spatial analyses. The equipment used for field surveys is the Global Navigation Satellite System (GNSS) Leica Viva GS08 + CS10. Building a database can easily become the most costly aspect of the project development [17]. At the same time, it might be the one which is going to consume the most time. In this phase is necessary a careful analysis of the objectives that need to be reached and prioritize the ones that are vital for the well being of the department [2].

5. Developing standards and procedures – A GIS is more than just software, hardware and data. It needs to include procedures and standards that allow data and other technological components of the system to function consistently and efficiently [12].

6. Online visualization – In order to ensure an efficient integration with other departments that do not benefit from specialized IT hardware, it is necessary to develop a method of distributing GIS generated content in a seamless way. When the system becomes

more widely-spread, such a visualization method becomes mandatory [9, 21].

7. Priority development/integration of applications – The system will need an environment which will allow it to be changed and updated in the future, as the various subsystems will need to be improved or replaced. This environment needs to be as flexible and as economically efficient as possible. These aspects need to be taken into account since the first phase of implementation. All systems that reach maturity will sooner or later require updates and modifications [20].

8. Developing an employee training schedule – As the system develops and is being adopted by more and more departments, the project manager must take into account the fact that not all of its users may have the required knowledge for interacting with it [19]. Because of this a training programme must be developed for the users so that all the information is being understood and its intensity must be adapted in such a way that the programme will be adapted to how each employee is going to interact with the system and its various GIS components [3, 21].

9. Project maturity – In an organisational environment, a GIS can not be implemented and afterwards left without a leader, coordination, support and room for growth. A department management system will have to be developed in such a way that operational efficiency, value and longevity will be guaranteed [11, 21].

RESULTS AND DISCUSSIONS

Developing a GIS for a company means developing a series of applications and tools that offer a complete solution starting with collecting data, continuing with processing it and finally sending the deliverables to the interested departments. A fairly new strategy is making available all of the geographical data to all of the departments, in such a way that the whole company is helped, satisfying the individual needs of each department. The advantages of such a setup consists of reduced information redundancy, improving data accuracy and integrity and the efficient

sharing and use. Since the data is the most valuable investment for a GIS, any approach that reduces acquisition costs while maintaining quality is important. Implementing a GIS can bring IT maintenance cost reduction. This way, the efficiency with which data is used and handled inside the organisation is increased and it covers the needs of all of the departments common standards, procedures and methodologies. For a company the advantages that a GIS brings can be translated into increased operational efficiency, the ability to integrate the geographical data into adjacent systems, workflow efficiency, accuracy, safety and improved data integrity, improved coordination amongst the departments, improved sharing procedures of data and improved system management.

This study is oriented towards a company, SC Avicarrvil SA, located in the Valcea county that next to its agricultural activities, also processes meat and produces fodder, which makes its water usage to be fairly high. Because of this, the need to implement a GIS that will manage and observe the use of water was highly needed. For the implementation of the GIS, the following steps were taken:

Planning the field survey with the GNSS instrument.

Field surveys using the Global Navigation Satellite System technology have become common for a wide variety of situations. The positional accuracy is strongly influenced both by the number of satellites available at any time and their relative position on the sky. Theoretically, satellite constellations are designed in such a way that at all times there will be at least four satellites available anywhere on the planet. The presence of natural or artificial obstacles and unfavourable meteorological events, reduce the visibility and the accuracy with which the positioning is made. Taking into account that there are available multiple satellite constellations and that the instrument that is being used is one that supports a wide range of them, planning the survey is not a critical step but it is necessary for confirming that the chosen method to survey is correct. On 05.06.2021 the maximum temperature was 23°C and the minimum temperature was 7°C. During the day the sky was covered in clouds only between 08:00 PM to 10:30 PM. There was no rain (Figure 1).

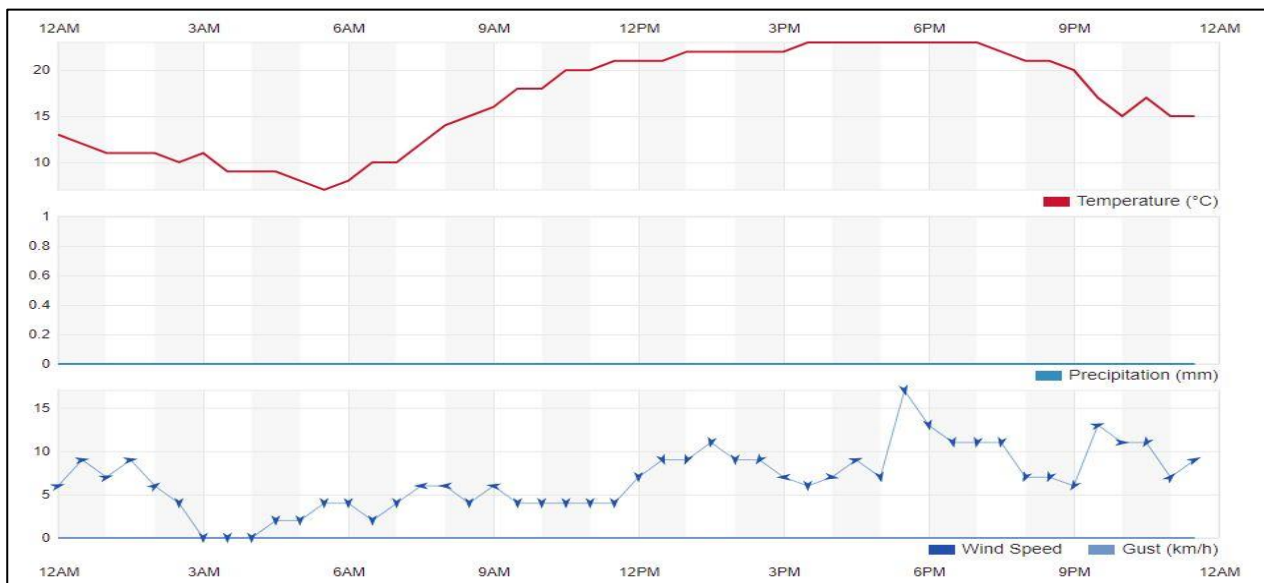


Fig. 1. Meteorological overview: Temperature (°C) and Precipitations (mm), on June 5th, 2021.
Source: own field observations.

Considering that the meteorological conditions are good, the next step is determining the ideal time of day for the surveyed location, for having access to as

many satellites as possible from the GPS-NAVSTAR, GLONASS and Galileo constellations (Figure 2).

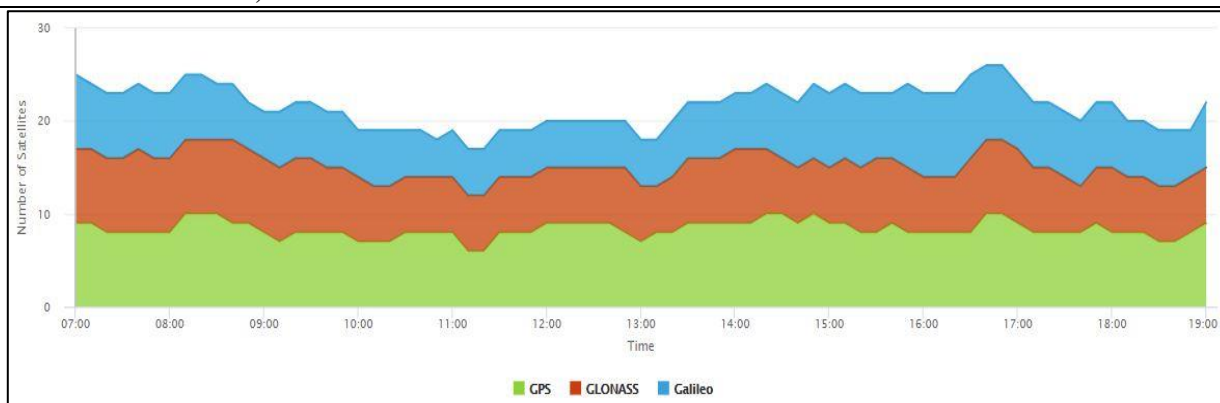


Fig. 2. Elevation (GPS-NAVSTAR, GLONASS, Galileo)

Source: own field observations.

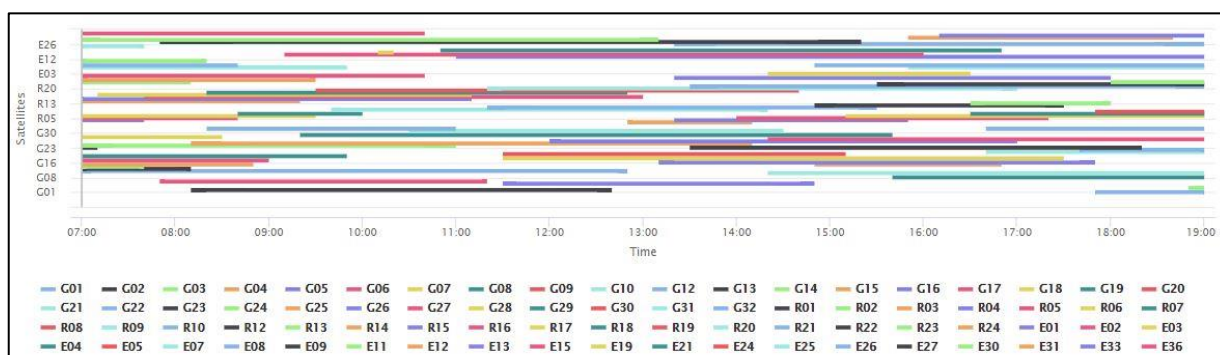


Fig. 3. Number of visible satellites

Source: own field observations.

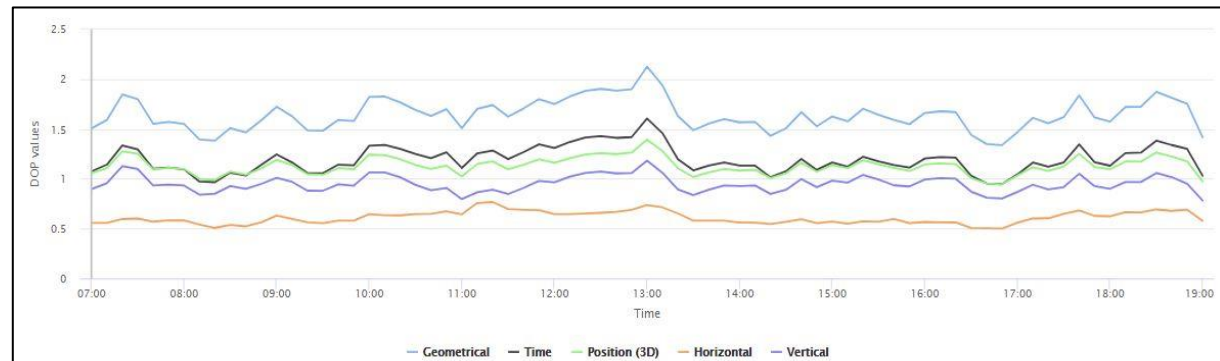


Fig. 4. Visibility period of the available satellites

Source: own field observations.

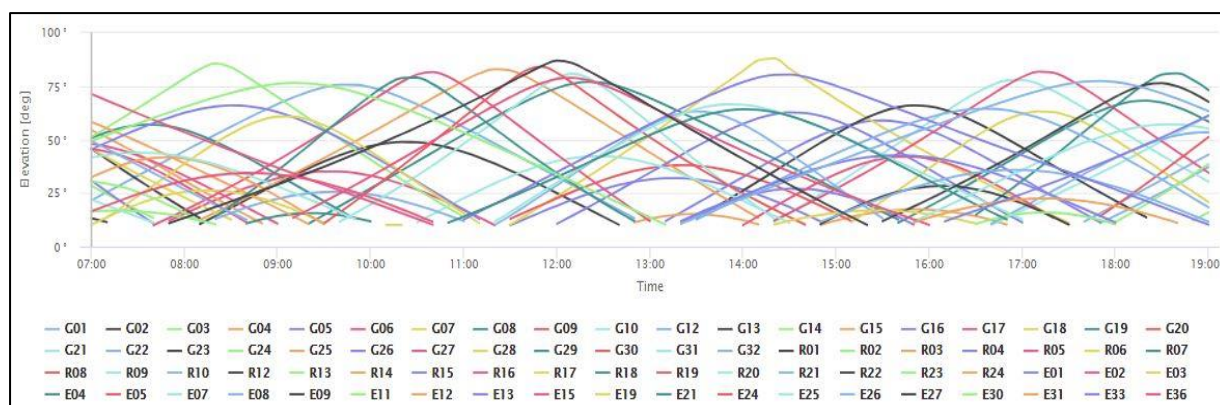


Fig. 5. Geometric dispersion of precision (DOP Values);

Source: own field observations.

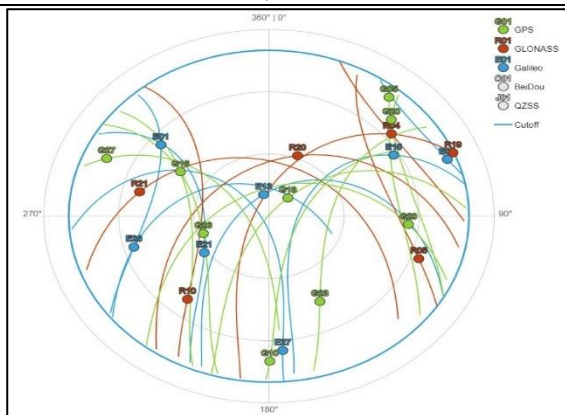


Fig. 6. Skyplot – Cutoff 10° (15:00 PM – 05.06.2021)
Source: own field observations.

The Figures 2, 3, 4, 5 and 6 above were created using the Trimble Global Navigation Satellite System (GNSS) Planning Online website, Trimble Inc., Ver. 1.5.0.0, accessed 05.06.2021 [24]. The graphs represent the position and constellation status in the day chosen for the field survey for the subject of this paper.

Initializing, configuring and performing the field survey

The field survey of the study area consists of assembling the GPS Rover, connecting it to the internet for the RTK communications, creating a working job, setting its parameters, establishing the coordinate system and finally performing the survey.



Photo 1. The contents of the Leica transport box
Source: own field observations.

A. Assembly The two main components of the Leica instrument – the controller and the GNSS antenna – are located in the transport box next to additional accessories. The GLS13 aluminium pole is also required for connecting the two (Photo 1).

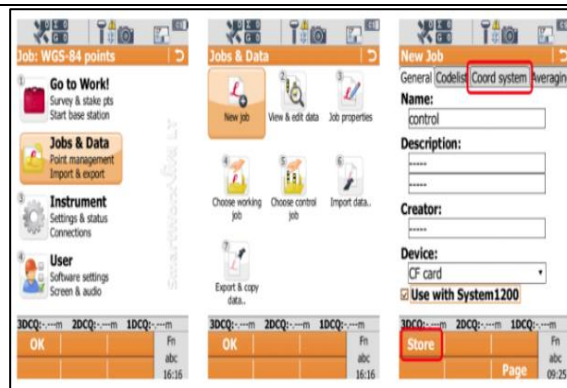


Fig. 7. Creating a control job
Source: own field observations.

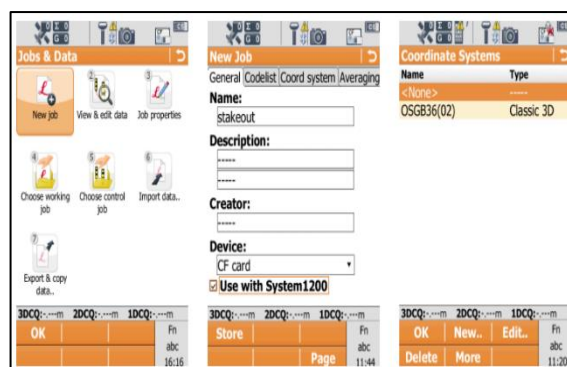


Fig. 8. Adding points into the control job
Source: own field observations.

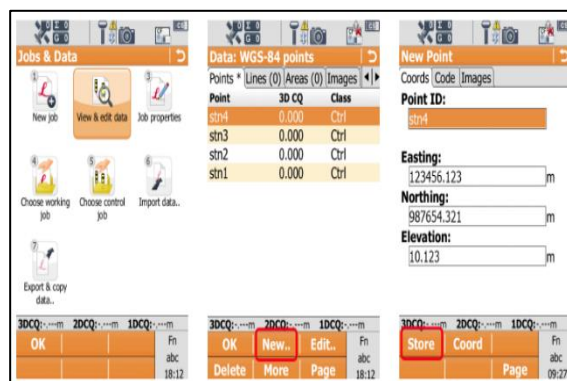


Fig. 9. Creating a stakeout job
Source: own field observations.

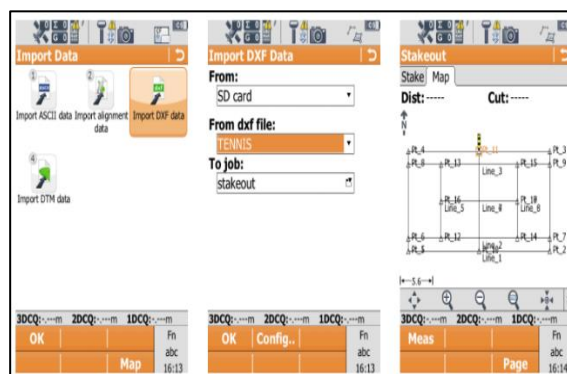


Fig. 10. Importing a DXF file into the stakeout job
Source: own field observations.

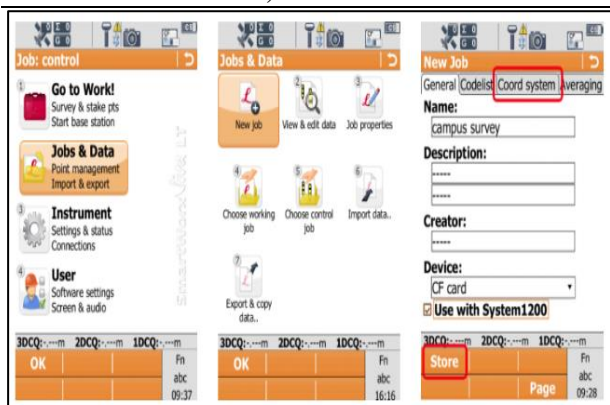


Fig. 11. The stakeout procedure
Source: own field observations.

Creating a control job

After setting the set to a so-called "SmartRover" configuration, the controller and antenna were turned on using the power buttons. The controller will boot-up Windows, from which you can double-click on the SmartWorx Viva Lite icon from the desktop. The main menu will be shown which contains 4 icons: "Go to work!", "Jobs & Data", "Instrument" and "User" (Figure 7). For creating a control job Tap 'Jobs & Data', 'New job', and create a job called 'control', storing the data to CF-Card or Internal Memory. To add text, use the pop-up touch-screen keyboard, pressing RETURN to store the text. The 'Coordinate system' (the 3rd tab)

should be changed to 'None'. It will be configured later. When finished, tap 'Store'. This will return you to the main menu.

Adding points to the control job

From the main menu, tap "Jobs & Data", then "View & edit data" and "New." to add the known control points. After point names and coordinates are typed in, click on "Save" (Figure 8).

Creating a stakeout job

A stakeout job has the purpose of storing known coordinates of points that are not materialised in the field and to determine their position. For example, it can store point coordinates for a future property boundary that can afterwards be marked. From the main menu click on "Jobs & Data" and set a name. In the "Coord System" section Stereo 70 coordinate system is chosen. This is the one used in Romania. After setting a name, click on "Store" (Figure 9).

After creating the job, the name and the coordinates of the points are added using the same steps as mentioned earlier. In order to be considered control points, names and coordinates must be added manually or imported via Comma Separated Values (CSV) files. It is also possible to add CAD drawings such as DXF files (Figure 10).

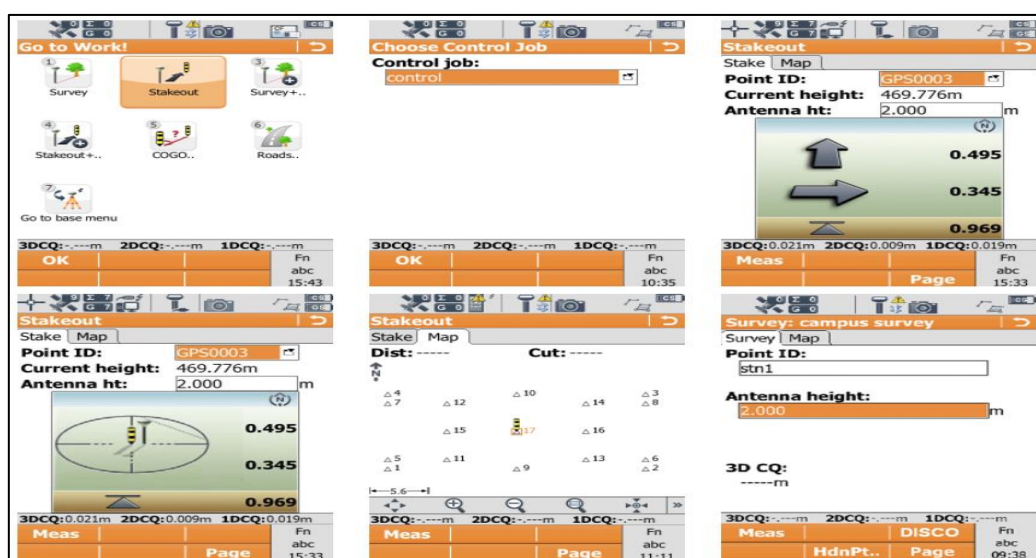


Fig. 12. Creating a working job
Source: own field observations.

After the correct import of the points that need to be marked in the field, click on "Go to Work!", then "Stakeout" and in the menu the

file that contains the control jobs needs to be selected. One of the points will be chosen from the list and the controller interface will

turn into a 3D target that aims to get the user as close as possible to the coordinates of the chosen point. After it has been identified, using the navigation arrows, the user can switch to another point (Figure 11).

This was necessary because in the study area there are a few elements whose position needed to be verified. It is about the safety boundaries of a micro-treatment plant and a water reservoir for whom fences were built. After the fast verification of their position, we move on to creating the working job which will store the objects resulted in the field survey necessary for the study.

Creating a working job for the field survey

For the field survey a working job is necessary which will contain all of the new coordinates that will be surveyed. Just like in the previous steps, click on "Jobs & Data", then "New job" and set an easy to identify file name. Different from the previous steps, this time we will define the coordinate reference system. In Romania, it is used the ETransDatRO option which allows for on-the-fly transformation of surveyed coordinates into Stereo 70 (Figure 12).

After the field survey was completed, there were 92 points that were identified and surveyed. They represent various elements of the water and sewer network. X and Y

coordinates can be found in Table 1 shown below. The topographical survey represents the first and easiest step of the whole process of collecting, processing and visualising the data but it is also the one that defines the level of quality and precision for the rest of the work.

It is the operator's job to collect all of the relevant information as detailed and as precise as possible. Usually, for each point, there are a series of notes and drawings. This is especially necessary for the sewer network. Just an identification code and a limited number of characters are not enough to provide all of the required information that can be identified in the field.

Each sewer manhole comes with a lot of details that have an impact on the way the entire network runs, starting from the ones that can be observed from the street level such as the manhole status, the locking ring and continuing with a detailed sketch that will contain all of the measurements that define that particular sewer network element. In a GIS, no matter how technologically advanced it is, if the data that is being input is wrong, the results from all of the spatial analyses will be wrong. The quality standard always needs to be maintained and fulfilled.

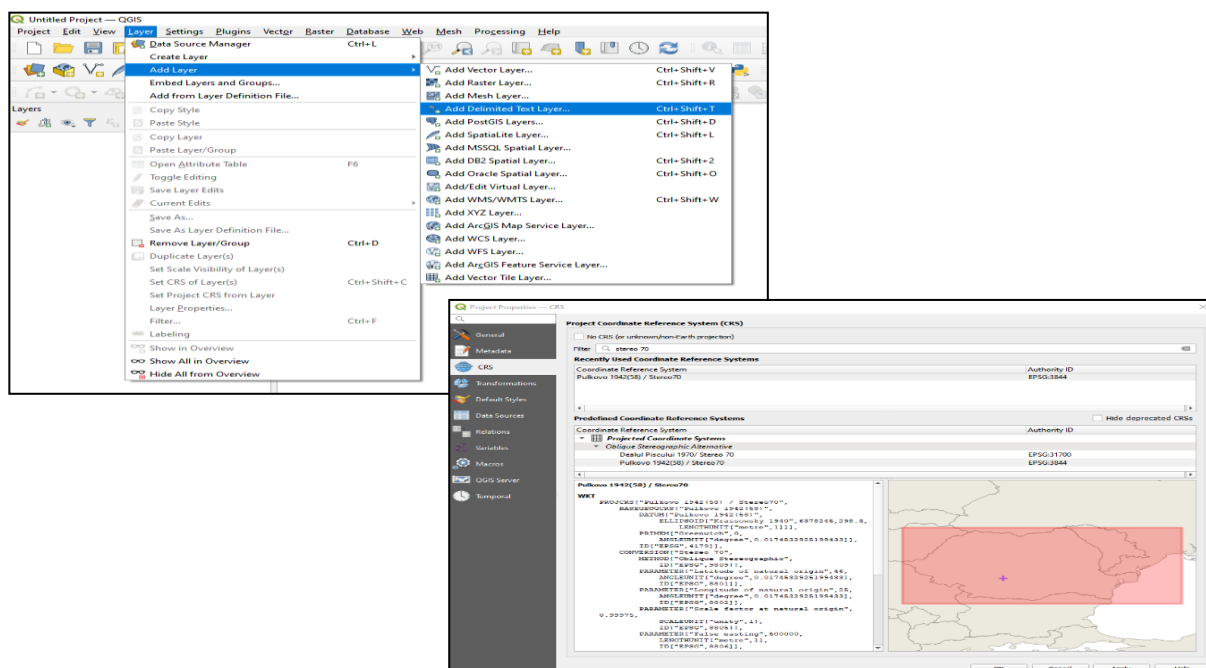


Fig. 13. Importing the Comma Separated Values (CSV) file and defining the coordinate reference system;
Source: own field observations.

Table 1. Coordinates X and Y of the surveyed elements

Nr. Point	X (m)	Y (m)	Nr. Point	X(m)	Y(m)	Nr. Point	X(m)	Y(m)
0	443175.439	394870.525	31	443178.752	394844.393	62	443095.472	394949.650
1	443059.107	394956.125	32	443114.837	394830.034	63	443140.013	394860.100
2	443139.878	395012.018	33	443084.469	394887.830	64	443117.935	394848.374
3	443096.442	394975.569	34	443138.915	394919.103	65	443182.755	394873.723
4	443130.593	394995.666	35	443189.731	394947.163	66	443176.636	394931.990
5	443080.077	394975.730	36	443156.825	395002.098	67	443169.529	394928.324
6	443195.044	394890.685	37	443104.665	394973.059	68	443100.364	394964.902
7	443043.725	394996.021	38	443051.933	394944.253	69	443169.864	394944.356
8	443062.648	395005.012	39	443036.136	395010.233	70	443115.295	394915.309
9	443077.536	395013.557	40	443069.534	395029.124	71	443269.116	394818.045
10	443082.037	394901.050	41	443124.205	395060.007	72	443227.267	394873.609
11	443154.913	394985.839	42	443054.120	395020.660	73	443216.427	394891.350
12	443150.711	394939.877	43	443174.117	394869.798	74	443057.782	394952.060
13	443134.943	394906.007	44	443058.766	394954.656	75	443260.882	394816.863
14	443097.418	394888.171	45	443196.460	394891.508	76	443120.086	395059.828
15	443065.360	394944.597	46	443082.686	394899.938	77	443015.397	395001.209
16	443138.129	394983.286	47	443080.894	394973.841	78	443152.638	395001.916
17	443130.097	394929.670	48	443129.173	394995.829	79	443048.576	394944.490
18	443123.654	394893.760	49	443139.793	395010.497	80	443114.434	394831.365
19	443094.082	394948.842	50	443076.957	395014.598	81	443232.073	394844.005
20	443119.573	394846.582	51	443061.921	395006.554	82	443236.021	394847.552
21	443139.289	394861.331	52	443043.215	394997.225	83	443236.785	394846.169
22	443180.753	394874.262	53	443094.806	394976.167	84	443231.462	394878.921
23	443177.870	394932.582	54	443153.899	394985.209	85	443260.878	394816.862
24	443167.104	394927.782	55	443151.662	394940.435	86	443120.016	395059.788
25	443101.745	394965.549	56	443136.426	394906.655	87	443015.663	395001.334
26	443170.688	394944.764	57	443098.623	394889.051	88	443048.433	394944.416
27	443116.204	394915.903	58	443064.294	394943.810	89	443152.475	395001.826
28	443260.678	394817.205	59	443136.870	394982.307	90	443114.281	394831.281
29	443224.035	394889.992	60	443129.106	394929.072	91	443231.351	394878.717
30	443171.589	394860.480	61	443122.713	394893.362			

Source: own field observations.

Processing the data from the field survey

The data was downloaded from the GNSS Rover as a Comma Separated Values (CSV) text document and it was imported into Quantum Geographic Information System (QGIS) 3.16 "Hannover". A CSV document is a text file that defines a table by using a comma or other symbols as a separator between cells. The document's rows, define the table's rows.

In this study, the table will have four columns separated by commas and on the following rows it will contain the "Point ID", "X", "Y" and "Z". Additionally, it might contain the column "Description" (Figure 13).

Although this type of file can store complex tables for a low storage value, for Quantum Geographic Information System (QGIS) is not that helpful because it does not contain important information regarding the coordinate reference system.

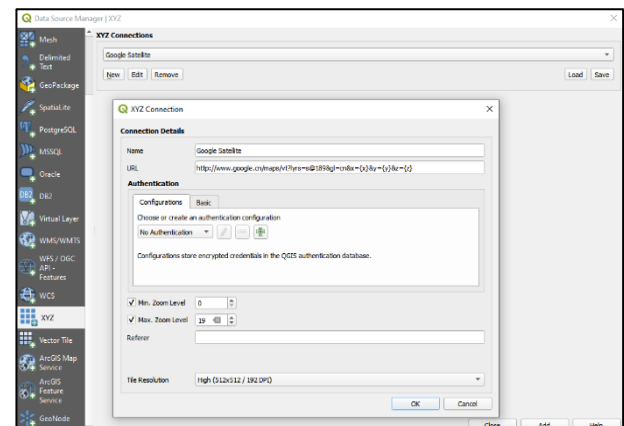


Fig. 14. Importing the Google Satellite orthophoto map
Source: own field observations.

The first thing needed to be done is to define the CRS. At the moment of import, the application will ask if the first row of the document represents the heads of the columns, which symbol defines the cell end, which are the columns that define the X and Y axis, if there is also a column that contains Z values and what is the coordinate system that

will be used for the project. In this case, the CRS used is EPSG 3844 – Pulkovo 1942 (58)/Stereo 70.

Following all of this, it is necessary to import an orthophoto map that will be used as a basemap for the elements that were surveyed. On top of it, it will be added the layer that contains polylines with transparent symbology but will have labels with the names of the streets inside and around the study area. The XYZ Tile Server service is an efficient and fast solution for this and it also has a high enough resolution for this project. Quantum Geographic Information System (QGIS) downloads from the Google servers orthophoto map tiles with a resolution of 256x256 pixels. The main advantage is that the computer does not need to download the whole raster like in the case of using a TIFF file. Quantum Geographic Information System (QGIS) will interrogate the Google server and download only the sections that are included in the workspace extent (Figure 14).



Photo 2. Adding details from the GIS interface
Source: own field observations.

When the user changes the workspace extents by zooming or panning, the program will load new tiles while the ones that might not be visible anymore will be stored in a cache for future use.

Most of these services follow the Google Maps standards: Tiles have a 256x256 resolution; Zoom level 0 allows for the rendering of the whole world; Each level of zoom will divide the old tile into four new tiles; 22 zoom levels are available and it is enough for most applications; The service uses the WGS 84/Pseudo-Mercator projection

which at the moment is the standard in industry, after it was adopted by Google Maps in 2005.

In simple terms, the coordinates X, Y, Z Tile Server service downloads a series of aerial photographs that have been georeferenced and ready to use. If the project's requirements are not met by this service there is always the possibility of contacting a company that has the tools and knowledge to provide aerial photographs that meet the requirements. In this case, the coordinates X, Y, Z Tile Server provides good enough data. From previous field surveys and employee knowledge, the GIS department already had information regarding the sewer and water networks of the study area but the level of precision required was not met.

Taking into account the fact that one of this GIS' objectives is to create a precise hydraulic model of the study area, the level of detail obtained from digitizing and other sources is not high enough. Eventually, all of the elements that belong to the water and sewer network will need to be repositioned with the help of precise topographical instruments. The GIS server stores geographical information that can be divided into three categories: "water network", "sewer network" and "topographical data".

The following steps towards completing the map and presenting the gathered information consists of importing SHP files that contain property boundaries, buildings, electricity and lighting poles, land use information and postal numbers (Photo 2).

The implementation of a GIS in the studied agricultural society, SC Avicarvil SA, Valcea County dealing with agricultural activities for producing fodder for poultry and poultry raising for meat production, processing and delivery, process which need a high amount of water, will lead to significant results. Below are all the final benefits that GIS has to offer:

1. Basemap/Data model – that contain the geometry and element attributes with a general level of information such as streets, property boundaries, buildings, land use, lighting and electricity posts, parking lots and many more. The map on which various spatial

analyses will be performed, it needs to have the highest level of geometric accuracy and quality of statistical data.

2. Software/Hardware – It is anticipated that a suite of software and hardware components will be needed for the successful implementation of the GIS. Where gaps are found, new software should be added. Also, it is necessary, in the majority of the situations, acquiring a data storage and sharing system – a server.

3. Online preview – One of the most important components of the system is the module capable of sending geographical data to a portal where visualising and interrogating data is available through an internet connection.

4. Standards/procedures – Promoting and adopting standards company-wide will insure system consistency, reliability and quality. Most often, the types of standards and procedures refer to the way of metadata manipulation.

5. Software development capacity – It will not be possible to satisfy all company requirements with just the help of commercial software. Because of this, it is necessary to introduce an environment in which software adaptation is possible and standardized.

6. GIS organisational programme – After the final implementation phase, the GIS needs to transform into an organisational programme. It will help promoting and coordinating GIS technologies especially during those projects that are critical for the improvement of financial processes and available services. Also, the programme will help tangent departments with standards, training, GIS technologies and improved performance.

From an economic point of view, the application of GIS in the agricultural society has led to the saving of a significant amount of clean water, used in meat processing and feed preparation processes. This was mainly possible due to the rapid ability to identify and manage all faults and breakdowns in the water distribution network. In meat processing and feed preparation centers, everything starts with water, it is used for watering and washing animals, washing trucks, washing carcasses and by-products, as well as for

cleaning and sterilizing equipment and processing areas. Water consumption rates can vary considerably depending on the scale of the technologies, their age and type of processing, the level of automation and cleaning practices. Typical figures for fresh water consumption are 2-15 m³, per tonne of live carcass weight. In most parts of the world, the cost of water is rising as the supply of fresh water becomes increasingly difficult, taking into account the real environmental costs. Water is thus becoming an increasingly valuable resource, and its efficient use is becoming increasingly important. Strategies to reduce water consumption may involve technological solutions or equipment upgrades. From the estimates made by the beneficiary it was concluded that, by implementing this system, the average daily water consumption was reduced by over 75 m³. This means a saving of clean water of over 1,575 m³ per month, which brings a net income of over 9,450 lei per month, and annually brings an income of over 113,400 lei, an amount that could be used in other sectors to modernize production processes. The reduction was mainly due to the total automation of water distribution processes, based on the data included in the GIS and the precise thematic maps prepared.

CONCLUSIONS

In conclusion, the study has lead to completing all of the proposed objectives such as: identifying and moving through the phases of planning, developing and implementing a GIS that has the purpose of storing, processing and presenting all of the topographical data that is in use by an agricultural company.

By implementing this GIS all the following risks have been removed:

-Conversion costs of existing data – Generally, geographical data collection and conversion are the most expensive activities. Since the beginning of the planning phase, the estimations for these steps were made as accurate as possible. A detailed evaluation of the needs for the data collection and

conversion period can offer a detailed overview for this phase.

-Departmental conflicts – Taking into account that an organisation-wide GIS is developed with the purpose of serving the majority of the departments through an integrated system, inevitably there will be contradictory opinions about how it should be managed. While this is inevitable in multi-departmental environments, during the GIS implementation, it was very important to achieve the objectives that were set. Communication and development procedures were implemented in order to not have delays and supplementary costs or situations in which the project is not ready for certain activities.

-Continuous support and coordination requirements – A GIS will not survive and offer reliability as long as it is not managed, coordinated and maintained by the staff. The entire technological framework is an expensive one and for the long term it can reduce costs associated with many activities but this is impossible without a dedicated team that is willing to achieve the objectives in an efficient manner.

-Complex technology – Although the front-end GIS has become a lot simpler and accessible for the average user, it is still important to take into account the fact that the technology and the processing algorithms that run in the background of GIS applications are more and more advanced as time passes. This aspect must not be ignored. If the required abilities are not available then all of the benefits that a GIS promises will not be accessible which is why our study company needs to benefit from teams that will be dedicated to the maintenance and implementation processes.

Because of the implementation of such a system, many advantages were obtained: It has become an important component in the information flow of the company with the help of its processing and visualisation abilities in an intuitive manner; Making use of all of the geographical data that is offered towards all of the employees no matter how good their desktop may be; Reduced reaction times no matter the issue that arises because

the access to correct information is done in an easy to understand manner and planning for a solution can be done in an efficient way.

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