FROM SURVEYING TO GEOMATICS

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Abstract
In the land surveying profession fast changes have been taking place in the last fifty years. Technological changes are generated by the Information and Communication Technologies; the analogue – digital trends; the automatic data acquisition methods replace manual ones; instead of two-dimensional base maps we use dynamic spatial databases more and more integrated into a global data infrastructure. However, these changes cause impacts also on scientific level. The traditional top-down approach substituted by bottom-up methodologies; in many cases the point-by-point measurement is changed by 3D laserscanning or Unmanned Aerial Systems, which produces huge amount of data, but it needs new algorithms for information extraction; instead of a simple data provision land surveyors support complex spatial decisions. The paper is dealing with some aspects of these changes. In the first chapter the authors would like to highlight the "data-information-knowledge" relations and the importance of changes in professional education. The second chapter gives an example of the benefits of a Global Spatial Data Infrastructure in spatial decision support. Finally we introduce a new concept (Building Information Modelling) in modelling the real world. However, until now BIM is used in building construction industry, it can can be a paradigm shift in geospatial information management in general.

Keywords: Land surveying, Geomatics engineering, Spatial decision support, Building information modelling

1. From data to information and beyond

Surveying (or more precisely land surveying) is the science and technology of determining the location of points, which were often used to establish base maps containing boundaries for ownership, building, etc. or the surface location of subsurface features (utility lines, mines etc.), or other objects required by government, industry (buildings, transportation, communication, etc.), development agencies or civil law. Surveying has its roots from the beginning of chronicled history. The changes were slow until the middle of the last century, when a new device was introduced: the computer. In the last fifty years computers have changed the work of land surveyors totally. First, it changed our computational habits radically in the sixties, afterwards the mapping devices and the data processing practice as a whole, and finally the entire way of thinking. Nowadays computers have been used only for a very low percentage for computing, they are totally integrated into our workflow, serving us within data acquisition, database developments, data processing, data analysis and visualization. The introduction of the Internet and the rapid changes of Information and Communication Technologies (ICT) caused fundamental transformation of our profession, which is exploring now best the ways how to serve the new e-Society.

Geomatics is a field that incorporates the older field of land surveying engineering along with many other aspects of spatial data management. Following the advanced developments in digital data processing, the nature of the tasks required of the professional land surveyor has evolved and the term "surveying" no longer accurately covers the whole range of tasks that the profession deals with. In Geomatics the location is the primary factor used to integrate a very wide range of data for spatial analysis and visualization. Geomatics engineers apply engineering principles to spatial information involving measurement sciences. Geomatics engineers manage local, regional, national and global spatial data infrastructures. The extensive availability and use of sophisticated technologies, such as Global Navigation Satellite Systems (GNSS), Remote Sensing and Geographical Information Systems (GIS) increase the precision and productivity of the profession.

Tabberer (2003) emphasises the need to make organisations not only 'data rich' but also 'information rich' and 'knowledge rich' as well. An organisation might be quite good at organising and using data (e.g. understanding the spread of performance and being able to analyse which departments tend to do worst); it may even be quite good at managing information (e.g. one part of the organisation knows what others are doing and planning). That does not mean it is good at managing knowledge (i.e. making what people have learned about what works available in a form which others can readily use). Data may help organisations benchmark their performance externally and internally. It may help them ask questions and recognize surface problems. However, without managing information, they will not know exactly who out in the wider world is doing better, and why. Finally, without managing knowledge, they will not be able to learn effectively and put what they learn into practice. Knowledge management (KM) is the process of capturing, developing, disseminating, and effectively using organizational knowledge.

Huge changes have occurred over the last twenty years in ICT for generating, sharing, and disputing human knowledge. Social media, "big data," open source software, ubiquitous computing, Wikipedia, etc. have altered the basic mechanics by which knowledge is produced and circulated. Figure 1 shows "data-information-knowledge" relations and underline the importance of geographic information (GI) knowledge infrastructure and knowledge management in the above mentioned sense.

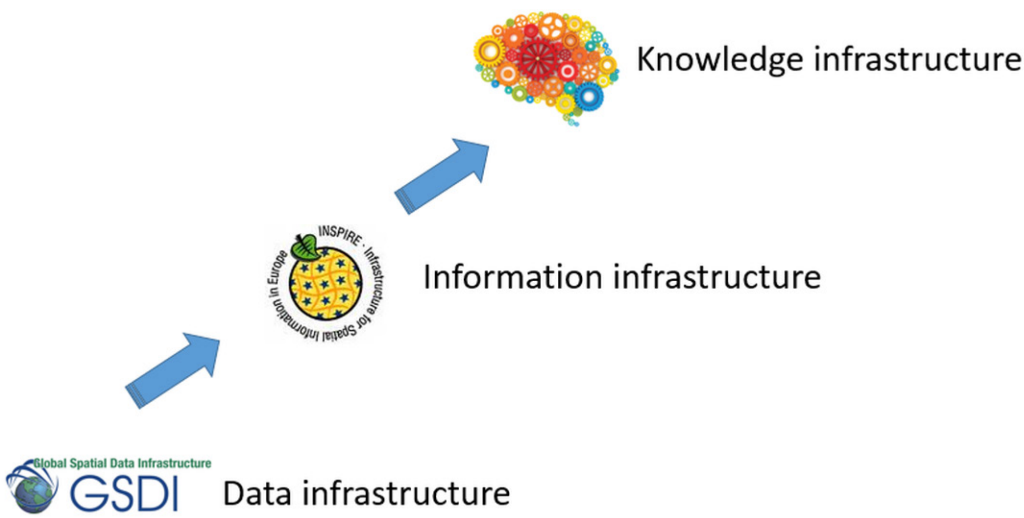

Fig. 1. In line with GSDI and INSPIRE, there is a need for GI knowledge infrastructure

The ICT have a crucial impact on our daily life, working routine education or learning. The revolution indicated by ICT holds great promise and opens enormous challenges. It is difficult to control but impossible to defend against. We are under a pressure of continuous changes, transforming all traditional way of learning, working to prepare our learners for their future.

In ICT the "analogue to digital" shift is almost behind us. Nowadays there is an accelerating move from "wired to mobile" and beyond. The new technologies allow ubiquitous computing as a new model of human-computer interaction in which information processing has been thoroughly integrated into everyday objects and activities. Using ubiquitous computing we engage many computational devices and systems simultaneously, and may not necessarily even be aware that we are doing so. This is a significant difference from the desktop environment. In ubiquitous environment it is possible to seamlessly connect "anytime, anywhere, by anything and anyone", and to exchange a wide range of information by means of accessible, affordable and user friendly devices and services. To highlight the mentioned "ubiquitous" character "u-Society" is often used for information society or e-Society. In such a society, people will be able to share information and knowledge easily which will help them realize their full potential in supporting sustainable development and improving the quality of life (Takahara 2005).

Educational institutions worldwide spend large amounts of money each year developing, adapting or acquiring learning resources and courses. The development of electronic learning resources is particularly expensive and often produces course materials that are platform or operating system dependent. This situation has led to discussion of the creation of standardized learning objects that can operate across hardware platforms and software systems.

Metadata will be fundamental in implementing similar systems. Whilst learning units form the building blocks of a networked and inter-connected environment, metadata is required to bind the units together and allow them to interoperate. Metadata is required to describe what learning units look like, how to build a learning route from them, what if any refinements or value adding operations have been carried out on a unit, and in a networked environment what services a tutor/learner can request from a server and what parameters the teacher/student should send to the server to request the service. Adopting a standards-based approach makes it easier to change system components in the future. IMS Global Learning Consortium IEEE (Institute of Electrical and Electronics Engineers) and Dublin Core provide a range of specifications that yield a standardised data format, allowing different systems from different vendors to work together. For seamless searching to work, the world has to agree on the specification of educational metadata (Márkus 2010).

2. GI application in agriculture decision making

This chapter gives an example of spatial decision support based on Global Spatial Data Infrastructure. Most of the processes in the world such as economic, social and environmental are essentially spatial and it is difficult to understand regardless of their spatial component. The relationship between man and the environment cannot be represented without a reference to a spatial location, because the environment is described by the topological relationships among physical objects (e.g., the soil or the air pollution in a given space-time location, the solar radiation on a given piece of land), and human activities produce impacts on the environment spatially (Campagna 2006).

Agriculture is a business sector ideally suited for the application of Geographical Information Systems (GIS) because it

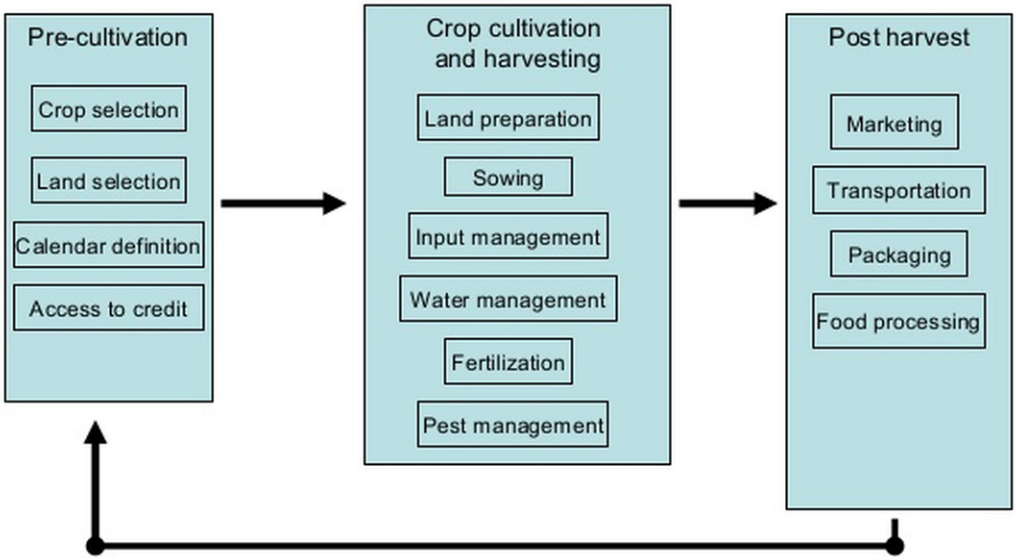

Fig. 2. Main phases in the agriculture sector
(Source: Think Piece Workshop, Wageningen, 2009)

is natural resource based, requires the movement, distribution, and/or utilization of large quantities of products and services, and is increasingly required to record details of its business operations from the field to the marketplace (Clay 2011). Considering numerous human activities during three main phases in agriculture such as: pre-cultivation, crop cultivation and harvesting, and post-harvest, is known that analysis and modelling of spatial data can be effective and efficiently carried out using GIS methodologies and tools (Fig. 2).

The GIS models can very well support the understanding and simulation of the various decision-making processes. As a result of a simple database query the decision maker does not often sufficient information for the preparation of the decision. However, in a complex decision making system, where multi-factor criteria relevant to the decision making aspects, hard and fuzzy boundary conditions and acceptable risk levels can be incorporated into the environmental model, resulting in a more valid decision alternative and the decision will have a much lower risk than through a simple query. Nevertheless, the process modelling is a fairly new field of GIS in both the environment analysis and the decision support processes. However, this area is very dynamic, newer and newer models are available in the GIS toolbar, new analysis capabilities are used for the more accurate, more extensive process analysis, respectively decision preparation. (Tamás 2011).

GIS has many impacts in the sector. In the following three benefits will be underlined. It is improving communication processes; it is an integrating technology; it is essential for spatial decision making.

A tool for improving communication

Considering human activities in agriculture, it can be stated that communication among institutions and farmers needs improvement. This is possible by managing the relevant information better. This management means the sharing of them as well. How can it be achieved? For example, during pre-cultivation phase it is very important to collect some information related to crops or select potential area for certain crops cultivation. In order to plan and manage the agriculture sector more efficiently it is necessary to share these information within an institution or among different institutions. Sharing of information must be realized in unified formats as maps, statistical diagrams or descriptive data. In addition it is important to distribute information to the farmers as well. GIS methodologies as well as integrating other information technologies can do this in the best possible way. A good communication among different stakeholders will help them to save time and costs as well.

As an integrated technology

GIS has emerged as very powerful technology because it allows for users to integrate their data and methods in ways that support traditional forms of geographical analysis, such as map overlay analysis as well as new types of analysis and modelling that are beyond the capability of manual methods (Foote et al. 1995). Considering the fact that GIS tools will serve to manage a large volume of data related to agriculture, we must be aware that these data come from variety of sources addressing a variety of themes within and among organizations all over the world. Data sources are principally related to technologies that are used to collect them. In the case of agricultural data, many technologies can be used: aerial photogrammetry, satellite remote sensing, terrestrial surveying, etc. In addition to that, in order to transmit information to others, data need to be analysed. In such cases other disciplines must be considered such as: computer science, geography, cartography, statistics, etc. So, GIS methodologies enable the integration of many data and many disciplines for solution of a complex problem.

As a Decision Support System

At an organizational or strategic level the most important aspect of GIS is its use in spatial decision support. Central to this is that GIS provides a framework for approaching, supporting and making spatial decisions. Decision support as a discipline has a much longer history than GIS. As such, much of the decision making theory is well established and has its own research field, computers have been used to develop decision support systems. Agriculture is one of the most important areas of human activity worldwide. As the population rises there is a need to increase the agricultural production. Agricultural modernization due to commercialization and labour intensive production between 1870 and the 1920s doubled agricultural production per land area (Olmstead and Rhode. 2009). Development of systems based on GIS methodologies help producers to manage their land more productively by creating information-dense reports and maps that give them a unique perspective of their operations. Monitoring market trends, improving yields, and predicting weather are among the many responsibilities required to reduce the risk of loss and increase profitability (Esri 2007).

The past decade has witnessed a tremendous growth in agricultural applications of GIS at a variety of scales. These applications have benefited from technological advances connected with GIS and several related technologies (including GPS, remote sensing, continuous data collection techniques, geostatistics, etc.). Using application software that is developed based on GIS methodologies should be a priority for farmers and agriculture institutions as well. Such systems will help them in following things:

- Greater analytical support for precision farming
- Better understanding of risk factors
- Higher revenue generation and cost recovery
- Greater efficiency through task automation
- Greater access to government services and data
- More accurate support for decision making
- Greater insight to policy making
- Easier reporting for government applications and regulatory compliance
- Better resource management

3. BIM as a new approach in modelling the real world

For many years classic GIS systems have provided the infrastructure and technology for representation of the world in digital maps using specific software and databases. Till recently 2D based GIS systems were in use from most of the GIS community. As the matter of fact they are still widely used in many GIS experts' daily work. Technological developments have emerged the necessity for higher standards in GIS as well. Especially during the last decade many big enterprises and individuals as well have focused their efforts in developing 3D GIS applications. Their efforts have been rewarded with the result of 3D modelling of the real world. 3D spatial operations have provided the tools for 3D visualization while data gathering technology as laser scanning for example have simplified the process of 3D data collection on the field.

But modelling the real world has never and will never be an easy task. The list of software available in the market nowadays is quite big and it is probably led by traditional CAD systems. But despite their ability to provide sophisticated techniques for geometric modelling they have limited capacities considering spatial analysis functions (Ozel 2000).

In the era of smart devices engineers and GIS community were searching for intelligent solutions for real world modelling. More than 40 years ago, the idea of BIM (Building Information Modelling) was presented for the first time (Silva 2011). It took almost half a century to re-consider this futurist idea as the concept for the present.

BIM also known as "parametric" modelling is a powerful computer-based system which allows architects, engineers and other experts of the field to create, visualize, test and continually modify digital models for the buildings. BIM should not be seen as limited only to the buildings, it can be applied in developing new plans for communities, industrial parks, urban revitalization for entire cities, etc. Despite the ability to register and offer detailed data for all the systems like heating, electricity, etc. within the buildings BIM also makes possible 3D presentation and visualization of the buildings and all this accompanied with the possibility for simulation and computations through the planning process (Borrmann 2010). As other GI systems are appropriate in visualization of

Fig. 3. BIM simulates construction methodology, sequencing and finances in a near perfect reflection of reality (Source: Resource Co-ordination Partnership)

the world, BIM has capacities and offers the technology for building management from the first idea to the planning process; from the construction process to the usage and during its "life" to its "death". BIM can be considered as the sum of almost all developments of the GI systems into only one system.

In simple terms, BIM is the process of creating models in the form of graphical and non-graphical data bases in a shared digital space known as a Common Data Environment (CDE). The data base builds in richness as the project stages progress until that complete data set is handed over to the client at completion. In the information model, we can add scheduling data to different components, generating accurate programme data for a project. This is known as 4D BIM. The next step is to produce accurate cost estimates from the components of the information model and it's this process that is known as 5D BIM.

Considering the priorities of BIM compared to traditional GI systems the UK government in partnership with private sector, have developed an industrial strategy aiming to get the world's leadership regarding BIM. They consider the BIM's ability in 3D modelling and designing management as a key agent to economic growth in both domestic and international markets (HM Government 2012). This new way of world modelling as presented in Fig. 3 is not just an idea anymore. Software companies supporting BIM offers concrete solutions.

4. Conclusions

Following the advanced developments in digital data processing, the nature of the tasks in land surveying has evolved and the term "surveying" no longer accurately covers the whole range of tasks. Geomatics is a field that incorporates the older field of land surveying engineering along with many other aspects of spatial data management. Universities are under a pressure of continuous changes, transforming all traditional way of learning, working to prepare learners for their future. The development of electronic learning resources is particularly expensive and often produces course materials that are platform dependent. This situation has led to discussion of the creation of a knowledge infrastructure that can be used both educators and learners.

Most of the processes in the world such as economic, social and environmental are essentially spatial and it is difficult to understand regardless of their spatial component. The GIS models can very well support the understanding and simulation of the various decision-making processes. However, effective spatial decision support needs Global Spatial Data Infrastructure.

The technology is changing rapidly, but the change of attitudes has strong barriers. In geospatial information sciences we model the real through set of layers, like cartographers did for centuries. The concepts of Building Information Modelling can be a paradigm shift in this area.

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