Geographical information systems and spatial data infrastructures can enhance planning. (case of Flanders)

by Greta Deruyter[1]

Although the use of geographical information systems (GIS) gained popularity in urban and rural planning activities over the last decade, there are still some difficulties to overcome before the use of GIS can be adopted as one of the most effective and efficient planning tools to be used in various circumstances.

This paper describes the two main constraints that restrict the use of GIS in planning, namely the lack of operational spatial data infrastructures (SDIs) and a shortage of well trained GIS experts. In this context the situation in Flanders (Belgium) is explained by highlighting the adequate (re)actions to both problems. More than ten years ago, the chalk lines towards developing a Flemish SDI were drawn by the regional government while in higher education more attention was given to GIS training and the evolution of the availability of spatial information. The positive effects of both evolutions for planning purposes are illustrated by a case study, showing how SDI resources can be used in the planning education, thus contributing to overcome still-existing barriers by innovating the curriculum for fruitful GIS adoption in the professional practice.

Introduction

Over the years geographical information systems (GIS) have become an increasingly important decision support tool in many disciplines such as marketing, risk management, urban and rural development, network analysis etc. However there still exist some problems concerning the availability of reliable up-to-date spatial data and well trained GIS

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specialists.

The availability of up-to-date data

In general

Although the production of spatial data is still a time-consuming process, over the last decade the availability and use of spatial data within local and regional authorities have significantly increased.

Nowadays improved data acquisition techniques allow efficient collection of spatial data for every desired scale level and purpose. Examples are to be found in the use of satellite images, aerial and terrestrial photogrammetry, aerial and terrestrial laser scanning (LIDAR), GNSS (Global Navigation Satellite Systems such as GPS, GLONASS, GALILEO) and terrestrial mobile mapping. Frequently, various techniques are combined in order to improve the accuracy and the overall quality of the final result. (De Clerck and Deruyter, 2011)

In spite of these positive evolutions, there are still some remaining obstacles in the use of spatial data (Gocmen and Ventura, 2010; van Loenen and Onsrud, 2004; Vanderhaegen and Muro, 2005). The most important barriers are summarised below.

- A lot of data is produced in function of a certain limited problem definition. These ad hoc produced datasets are often incompatible with other datasets and as a rule not kept up-to-date. This leads to multiple production of similar data sets by different organisations, thus wasting valuable time and resources. Data should be collected only once and an efficient actualisation should be foreseen before the start of the data gathering.
- Spatial data from different sources are produced in various reference systems which can lead to unintended overlaps or “holes” in the data, due to co-ordinate transformations.
- The intended scale level of an application has an impact on the degree of detail that is required. As a lot of the times data is produced in function of a limited problem definition, this often also leads to double production of the same data sets each with its own level of detail.
- Frequently it is not easy to discover what geospatial information is available, how it can be acquired and how it has to be used.

The European answer

The problems mentioned above are addressed by the European Union framework directive called INSPIRE. INSPIRE stands for ‘INfrastructure for SPatial InfoRmation in the European Community’. This INSPIRE Directive aims to create a European Union (EU) spatial data infrastructure (SDI) beyond national boundaries and will enable the sharing of spatial information among public sector organisations and better facilitate public access to spatial information across Europe (INSPIRE, 2007).

The Directive is based on five main principles.

- Data should be acquired only once and maintained at the level where this can be done most effectively.
- It must be possible to combine seamlessly spatial data from different sources across Europe and share it between many users and applications.
- It should be possible for spatial data collected at one level of government or scale to be shared with all levels of government or scales. The information should be detailed enough for thorough investigations and general for strategic purposes.
- Geographic information needed for good governance at all levels should be readily and transparently available.
- It should be easy to discover which spatial data is available, under which conditions it can be acquired or used and to evaluate its suitability for a particular need.

SDIs are internet-based information systems which have as primary objective to facilitate accessing, sharing and disseminating geospatial data. This is done by implementing standards for data specifications and sharing and – very important – has to be supported by national policies. SDIs are seen as a means to promote economic development, allow better government and environmental sustainability. (Masser, 2010) Sub national and national SDIs can be interconnected, thus forming supranational SDIs (Granell et al., 2010; Masser, 2010).

In essence SDIs allow the sharing of spatial data sources coming from a multitude of disciplines, thus enabling users like urban planners to save resources, time, and energy by avoiding duplication of expenses associated with the generation, maintenance, and integration of data (Mansourian et al., 2008). Recently two studies on the socio-economic impacts of regional spatial data infrastructures substantiate with real evidence the costs and the benefits of SDIs in comparable regions of Europe. Quantitative evidence of the benefits has shown how quickly the investment made could be recovered. (Craglia & Campagna, 2010).

To ensure that the spatial data infrastructures of the member states comply with the INSPIRE Directive, common Implementing Rules (IR) are adopted in a number of specific areas such as metadata, data specifications, network services, data and service sharing, monitoring and reporting.

The INSPIRE Directive came into force on 15 May 2007 and will be implemented in various stages, with full implementation required by 2019. Each member state is responsible for putting the INSPIRE Directive into practice and create or adapt its own spatial data infrastructure. The SDIs of the member states will be integrated, thus becoming a European Spatial data Infrastructure.

The answer of the Flemish Region

In Belgium the authority to translate the INSPIRE Directive into legislation was transferred to the Regional Governments: the Governments of the Flemish, the Walloon and the Brussels-Capital Region. Collaborations have also been formalised between the regional SDIs and the federal agencies, including the National Geographic Institute (IGN/NGI), which coordinates the reference systems and geographical names; the General Administration of Patrimonial Documentation (AGDP / AAPD) which deals with cadastral parcels (European Commission & Joint Research Centre Institute for Environment and Sustainability, 2009).

The Flemish Government, however, did not wait until the INSPIRE Directive came about to begin organising its regional SDIs.

In 1995 the Flemish Government established a framework and partnership "GIS-Flanders". The main goal of GIS-Flanders was to coordinate, control, guide and support a multitude of initiatives in the field of geography, which were seldom in harmony with each other. At the same time, GIS-Flanders wanted to improve the collaboration between the regional, provincial and local authorities with regard to geographical initiatives. This framework was further institutionalised by a decree in 2000. The Agency for Geographic Information in Flanders (AGIV – FGIA) is the successor to GIS-Flanders since 2006.

On the 20th of February 2009, the Flemish Government ratified the decree on the Geographical Data Infrastructure Flanders (GDI-decree). This GDI-decree has replaced the decree on the Geographical Information System (GIS-decree) and has assigned the responsibility for the coordination of the operational development of the Flemish Geographical Data Infrastructure to the FGIA. At the same time, the Flemish Government realised, with the GDI-decree, the transposition of the European INSPIRE Directive, which main objective is to provide area covering and harmonised geographical information in a smoother way.

The GDI-decree is built on the concept of 'authentic geographical data'. The Flemish Government has certified the topicality, accuracy and exhaustiveness of these data.
Two other important concepts of the new decree are the 'decentralised management' and the 'multiple' access. Geographical data are managed at the administrative level, where this can be realised most efficiently, subsequently these data are fully shared through a network model. This should guarantee a more efficient functioning of the government and smoother contacts with civilians.
Within the European Union, not only must there be basic data at one's disposal, services have to be developed, as well, to explore, consult, download and treat geographical data.
This requires coordination between the users and suppliers of environment related geo-information, in order to be able to combine information from various member states and sectors.
The GDI-decree states that the interest grouping GIS-Flanders is transformed into the interest grouping GDI-Flanders and enlarged towards, amongst others, Flemish inter-communal interest groupings, the local police and educational institutions. They have free access to the Geographical Data Infrastructure Flanders. With this advanced access policy, Flanders remains a pioneer within the European Union. (FGIA, 2011; European Commission & Joint Research Centre Institute for Environment and Sustainability, 2009)

This and more information on the activities and services provided by the FGIA can be found via http://www.agiv.be

The use of GIS in urban and rural planning

Software to process spatial data has known a vast evolution. A lot of progress has been made in for example image classification, visualisation techniques and possibilities for combining and analysing data generated by different data providers and in different data formats. Geographical Information Systems (GIS) are software used to build, store, manage, integrate, analyse and visualise spatial data or by extension, all data with a spatial component.

Because of an increased access to datasets, software developments and the promotion of geospatial technologies through higher education, over the last decade the use of GIS in planning activities has increased significantly (Gocmen and Ventura, 2010). However, the opportunities offered by the use of GIS are not fully exploited in public planning (Merry et al., 2007). A lot of the time GIS is not used for high level tasks such as modelling or spatial analysis. More often only the cartographic tools are utilised, for instance to make simple maps used as an illustration in presentations or brochures or to retrieve information, make inventories of a certain theme etc.

Recent research on uncovering the main barriers to the use of GIS in planning confirms that the obstacles to GIS use in local government are similar to those of the past, but not identical (Drummond and French, 2008; Gocmen and Ventura, 2010).

The technological possibilities of GIS are no longer the greatest barrier. Nowadays training, funding, and data issues seem to be more important hindrances in a more widely spread use of GIS for planning purposes. Moreover, planners are often not fully aware of the full potential GIS can offer. (Gocmen and Ventura, 2010)

Although the recent research of Gocmen (Gocmen and Ventura, 2010) point out some obstacles in the use of GIS, there are also more and more success stories to be told, which indicate that Geographic Information Systems are increasingly used to support decision-making in spatial planning. The awareness rises that GIS offer the opportunity to augment conventional assessment techniques by acting as visual mediators of spatial knowledge and by providing an effective tool for the spatial and temporal analysis of environmental impacts. Moreover GIS have the potential to increase the objectivity and accuracy of the assessment, enhance both the understanding of environmental and planning considerations and the delivery of information. (Gonzalez et al., 2011)

The role of higher education the Flemish Region

Higher education can play an important role in lowering the thresholds for the use of GIS in planning. As a result of the GDI-decree higher institutions now have free access to the Geographical Data Infrastructure Flanders, enabling them to use GIS to their full potential in both research and training.

Following example illustrates a somewhat simplified version of one of the assignments given to students enrolled in the MSc in Land Surveying (former Industrial Engineer in Land Surveying).

Case study: Example of a planning assignment given to students enrolled in the MSc in Land Surveying

Context:

Spatial decision problems often involve a large set of evaluation criteria to be assessed by several individuals or organisations, which often have conflicting interests and unique preferences with respect to the relative importance of the criteria which form the basis on which alternatives are evaluated (Malczewski, 2006).

The case study at hand involves a project developer in search of ten suitable parcels for a housing development project in the community of Laakdal (Flanders). The required parcels need to meet some stringent constraints and there are also some less stringent constraints (preferences). While the stringent constraints need to be fulfilled, the preferences may be altered if not enough suitable parcels are found. This means that, to save time, a model will have to be composed in which the preferences can be parameterised, thus allowing them to be altered in a flexible way. This will enable the automation of the selection process and consequently save a lot of time.

Constraints:

Stringent constraints are that the selected parcels have to be free of constructions and situated in zones allocated for habitation according to the development plan.

The problem definition also contains a list of less stringent constraints. Each selected parcel has a surface area between 750 and 1000 m² and is by preference located:

- within a maximum distance of 2,0 kilometers to an outdoor recreation area, 500 meters to a park or forested area and 3,5 kilometers to a motorway;
- outside a minimum distance of 2,0 kilometers to an industrial zone and 150 meters to a river, stream or canal.

Selection or planning process:

To find a solution to the formulated problem, different data sets (the Large Scale Database, the development plan, the streets atlas and the hydrographical atlas) and some analysis tools will be needed.

The data sets are provided by the FGIA.

The GIS software used is ArcGis (Esri).

In Fig. 1 to 3 some of the intermediate results are shown.

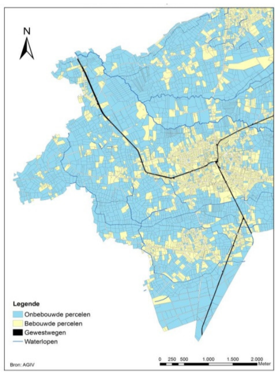

Fig. 1: Community of Laakdal: parcels free of constructions in blue (Large-Scale Reference Database – FGIA)

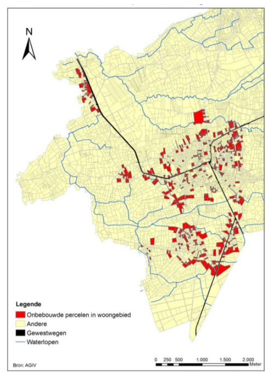

Fig. 2: Community of Laakdal: in red the parcels free of constructions and situated in zones allocated for habitation (Large-Scale Reference Database and development plan - FGIA)

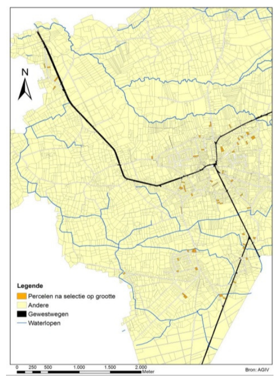

Fig. 3: Community of Laakdal: in orange the parcels free of constructions, situated in zones allocated for habitation, with a distance to motorways < 3,5 km, distance to outdoor recreation areas < 2 km, a distance to parks or forested areas < 500 m and a surface area between 750 and 1000 m²
(Large-Scale Reference Database; development plan; streets database-FGIA)

Further application of the other criteria on the remaining parcels leads to an empty selection. Hence the preferences will have to be changed.

By introducing a model (through the modelbuilder tool in ArcGis) the criteria are parameterised, thus allowing a highly flexible work flow. Fig. 5

shows the model used for the automation. The selection criteria are introduced in the model by using the option of adding parameters (Fig. 4). Thanks to this model it only takes one or two minutes to change the selection criteria and produce a new alternative.

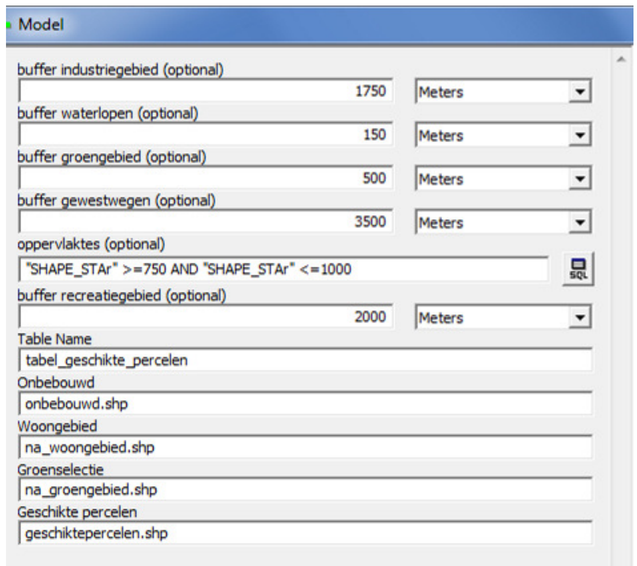

Fig. 4: Parameters of the model can be adapted each time the model is run.

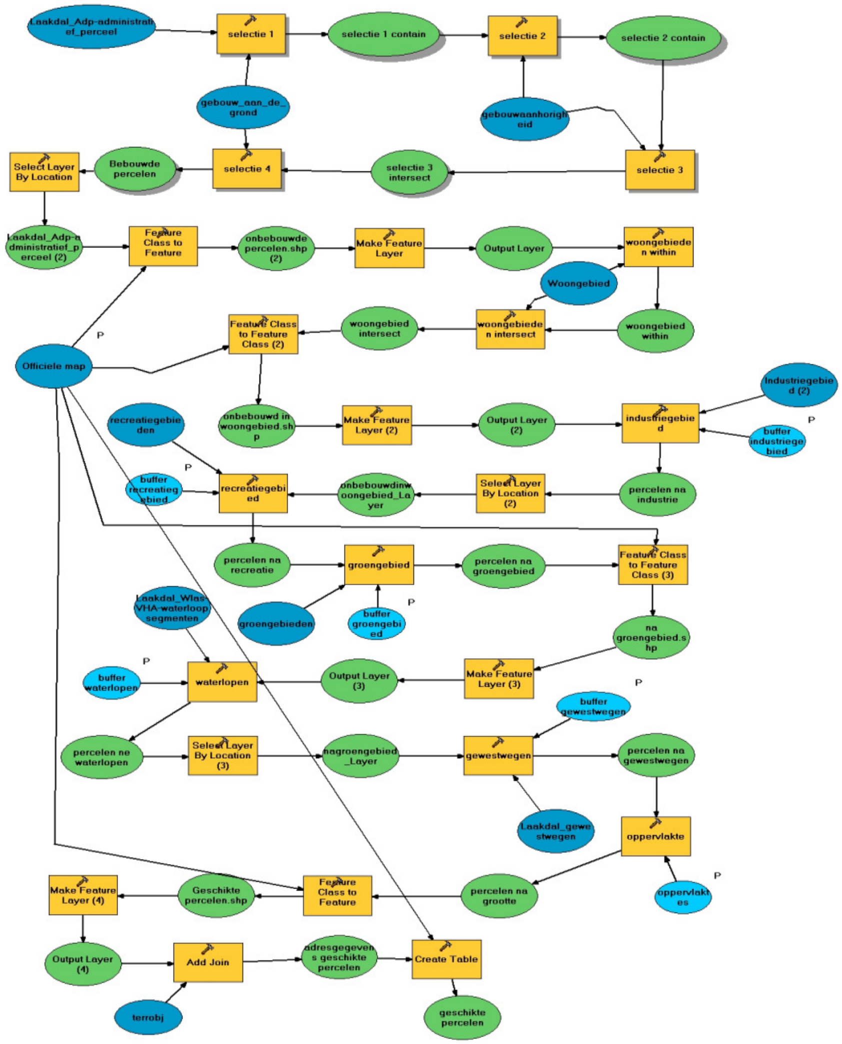

Fig. 5: Model created in the modelbuilder tool of ArcGis

After a few test runs with varying values for the parameters a final result is produced (Fig. 6).

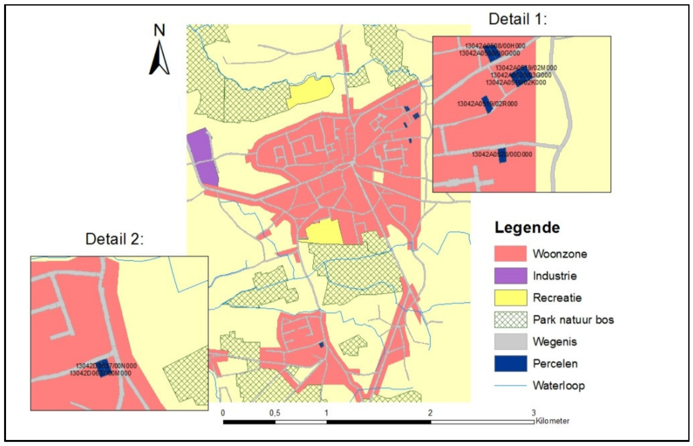

Fig. 6: Final result (parcels in dark blue) after a few test runs of the model with different values for the parameters.
(based on the Large-Scale Reference Database; the development plan; streets database-hydrographical atlas (VHA) – provided by FGIA)

Conclusion

GIS contain versatile tools for building, managing, analysing and visualising spatial data and although GIS are still not always used to their full potential in planning due to the unavailability of adequate spatial data and a shortage of well trained GIS experts, Europe is moving in the right direction.

Even in this early stage of the implementation phase of the INSPIRE Directive in the member states, positive effects are already visible. This paper illustrates how “easy” an analysis of spatial data can be, provided that the planner has a thorough knowledge of GIS and even more important, provided that compatible, area covering, reliable spatial data sets are available.

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