The use of digital information in a municipal spatial structure plan

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Abstract

The benefit of linking digital data with geographical maps has always been underestimated in the spatial planning of Flanders. Today, the planning methods in Flanders have evolved from a static land-use planning to a dynamic, more flexible planning: spatial structure planning. The general idea is to come to a consensus between the different fields that have a need for land occupation. Understanding ones needs, it should be easier to make decisions based upon a mutual insight of problems and opportunities regarding spatial planning. How does one examine spatial structure plans, problems and opportunities using digital information? All different fields have their own methods of gathering spatial information and storing it digitally, what results into a large amount of data. This paper describes the use of these data in a spatial planning process: the conditions in which to use databases, how to link different data to spatial maps and how to work with overlays in order to formulate conclusions regarding spatial planning. Last but not least, we have worked out a way to import GIS-data in non-GIS-programs in order to produce attractive charts that can 'sell' spatial planning ideas to the public. The main purpose of this paper is to demonstrate the importance of using digital information in spatial planning and the necessity to have a constant dialogue between spatial planners and GIS-experts in order to make models that are suitable for spatial planning.

1 INTRODUCTION

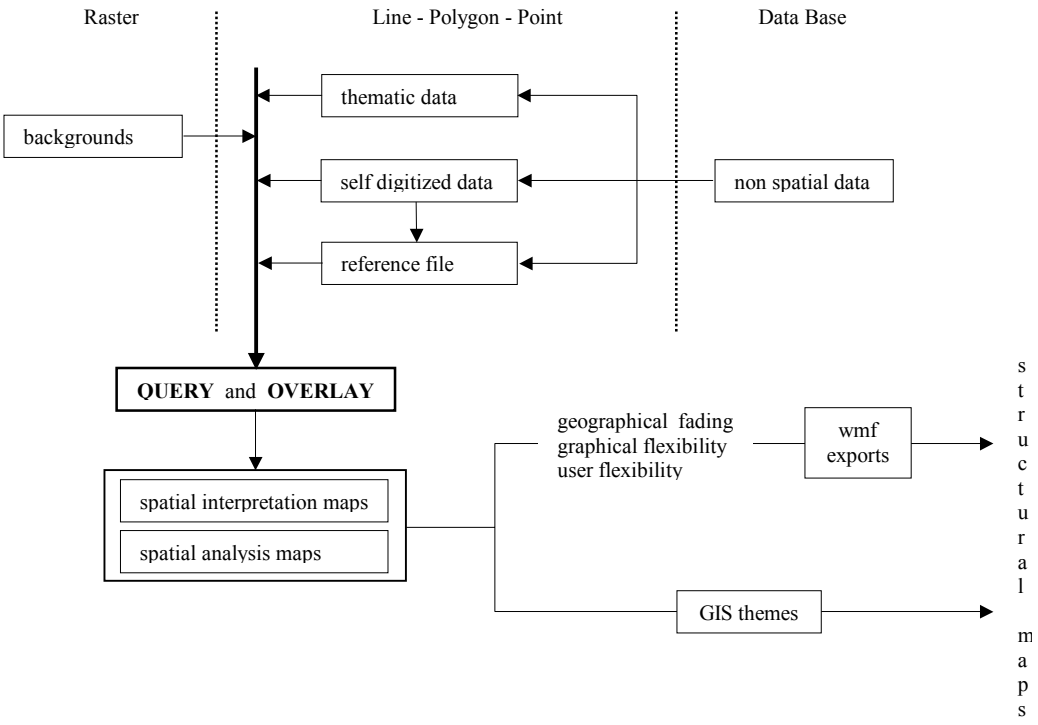
Spatial planning in Flanders, up to now mainly based on regional land-use destination plans, has over the last few years undergone some major changes. Regional plans, all going back to the seventies, determined land uses that remained unchanged for more than thirty years, making that the spatial planning could insufficiently go along with dynamic social processes. By spatial structure plans as a central intermediate step towards future implementation plans one has tried to bring some changes into this. Based upon the targeted examination, one tries to discover and to define existing spatial structures in order to translate the fundamental land-use principles of an area in a desirable spatial structure. Considerable research is done into analysing spatial structures and the way they interact with one another. At the very least, the following structures need to be examined: the housing structure, the economic structure, the traffic and transportation structure, the natural structure, the landscape structure, the agricultural structure and the recreational structure. (Stichting Leefmilieu v.z.w., 1998: 446) Each of these structures should be organised in relation to the "physical structure", also called a-biotic environment (geology, relief, soil, water, etc.), which builds as it were the bottom layer upon which the other structures and the land use are engrafted. To avoid slipping back into a static land use, a periodical review of spatial plans is foreseen, taking into account that the major spatial planning principles remain unaltered over a longer period and that a social interaction is to be pursued.

The key issue here is how digital information obtained through the GIS (Geographic Information System) can be used efficiently in the planning process. This paper will first consider the basic requirements necessary to implement GIS in spatial planning. We will then examine how we can use GIS in the Flemish context when examining existing spatial structures and how we can detect spatial interactions and bottlenecks. Finally, we will check if GIS is the most suited tool to reflect desirable structures and to which extent GIS can support the presentation methods of a desirable spatial structure. A central flow chart will illustrate the entire process. All conclusions are presented using a characteristic example from the spatial structure plan of Nijlen. This municipality is situated on the borderline between urban and rural and combines complex built-upon spatial structures and open spatial structures.

2 THE USE OF GIS IN THE SPATIAL STRUCTURE PLAN OF NIJLEN

The essence of GIS is linking non-spatial data to spatial data, i.e. lines, dots or polygons. Through "query" we can retrieve data in a targeted way whereas overlaying different digital spatial files can enable us to make statistic and spatial analyses. Subsequently, their results can be visualised efficiently. The last step of this visualisation is made – depending on its function – through GIS, CAD or word processing. Visualising GIS-files in a recognisable way sometimes requires a "background" as reference. To this purpose digital raster graphics are used, adjusted to the desirable scale (topographic map, land registry map, orthophotograph, …). In an optimal scenario one also uses a vector reference file, in which new spatial information can be saved. The diagram below (diagram 1) illustrates the overall process.

diagram 1. Overall process regarding GIS-applications in spatial planning



2.1 Basic requirements to enable the use of GIS in a spatial structure plan

2.1.1 The availability of a reference file

For digitally processing spatial data one needs a large-scale reference file (GRB), more specifically a reference file based upon individual parcels with a high degree of cross-border uniformity. Several European countries are working on such a file or have already completed it. In Flanders one is working on an area-covering GRB. It concerns a vector reference (polygon) file based upon the land register, engrafted on the Lambert 72-coordinates system and highly accurate. Each parcel has a unique coded identification number to which individual data can be assigned (permit situation, inventories made, etc.). Its completion is planned for 2014. Awaiting such file, one uses today a digital raster graphic based upon the land register parcels, using a field version as background. All relevant information is assigned as much as possible to this file, enabling spatial analyses and overlays.

2.1.2 The availability of thematic basic files

The availability of a minimum amount of basic maps is essential to incorporate GIS in spatial planning. Digitalising these maps is time-consuming; it is a considerable asset if one can have fluent access to externally supplied basic data. In Flanders *OC GIS Flanders* coordinates the establishment and distribution of basic files. The table below gives a survey of thematic files that can be used when drawing up municipal spatial structure plans.

Tabel 1. Survey of thematic files and applicability per partial structure

Thematic information files		Spatial structures						
		nature	Landscape	agriculture	housing	Business-industry	traffic	recreation
Judicial	administrative boundaries	x	x	x	x	x	x	x
	zoning plans	x	x	x	x	x	x	x
	protected landscapes and sights	x	x	x	x	x	x	x
	statistic sectors				x		x	
	protected habitat areas	x		x			x	
	manure protected areas	x		x				
Land use	land use maps	x	x	x	x	x		x
	built areas				x	x	x	x
	agricultural land use maps			x				
	specific farming land inventory			x				
infrastructure	road maps, railroad maps	x	x	x	x	x	x	x
	traffic accident inventory						x	
vegetation	biological survey maps	x	x	x				x
	forest maps	x	x					x
	Ecosystem vulnerability maps	x					x	
soil	soil maps	x	x	x	x	x	x	x
	processed soil maps			x				
water	hydrological maps	x		x	x	x	x	x
	watercourse maps	x	x	x	x	x	x	x
agriculture	land consolidation areas			x				
landscape	relict maps		x				x	
	landscape region maps		x					

Completing missing spatial data through self-digitalisation must always be balanced against its surplus value, also considering the fact that a periodical update is required. However, its efficiency can be raised by using targeted “entry scripts”. Entry scripts are minimum programmes, custom-made within the GIS-framework in view of a specific goal to enter data.

2.1.3 The efficient management und updating of digital spatial data

The analysis of existing spatial structures requires the use of a considerable amount of spatial data. As the implementation of GIS often occurs bit by bit, the amount and diversity of the data turns out only lately, when it is still hardly manageable. The need for proper data management is not only based on the quantity but also on the variety of information used by GIS. Then the spatial basic data (externally supplied or digitalised internally) can result into a great deal of new data through queries and analyses. The variety is the result of the diversity of file types (digital raster grapfhics, thematic GIS-files and non-spatial data files) and the diversity of spatial entities to which they refer. Investing in an early stage in the organisation of digital spatial data is therefore highly recommended, also because correcting them later is a lot more labour-intensive. Digital spatial data management, aiming at a logical and transparant file structure, is therefore indispensable for an efficient use of the available data.

A critical success factor for a spatial information system is keeping its data up-to-data. A periodical review also requires dynamic data management. When externally supplied basic data are being used, the supplier can be expected to do the updating. For the other data a systematic update must be incorporated.

2.2 The use of GIS when examining existing spatial structures

2.2.1 The need for an unequivocal definition of existing structures

GIS is ideally suited to distil maps – fast and targeted – from a large amount of information. Classic operations in this regard are simplification (interpretation) of spatial data, thematic queries and the spatial overlay of various data. However, before starting to examine a spatial structure, it is necessary to give one unequivocal definition for the functional elements determining the spatial structure. These spatial-functional elements must be known before one can establish the required interpretations, queries and overlays. The following examples illustrate this process.

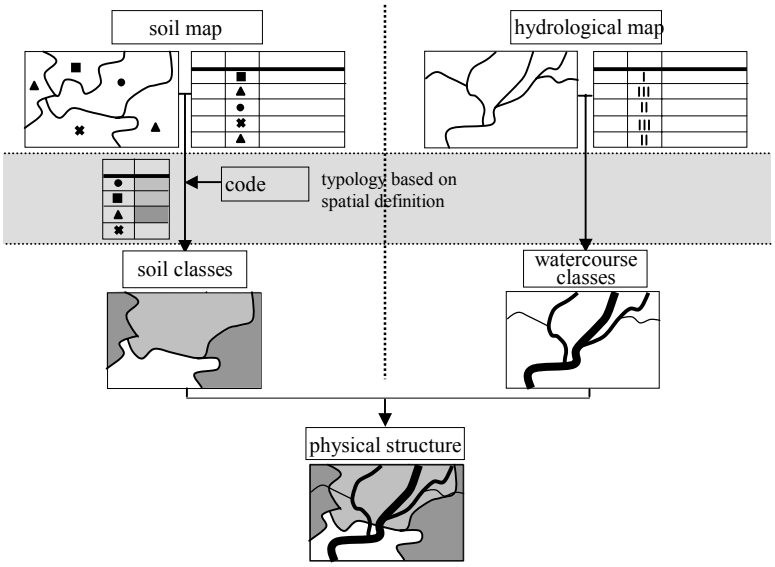
2.2.2 Case study Nijlen: GIS-translation of the ‘physical structure’

A definition of the physical structure is found in the Spatial Structure Plan Flanders (RSV, 1997: 95): ‘the physical structure is the whole of properties and processes of and mutual relations between climate, geology, relief, soil, surface water, groundwater and air. The internal relationship between these elements is very important’.

In the context of a spatial analysis per area one looks mainly for the relation between soil properties, relief and the influence of the water system. The soil map of Belgium codes the soils using 3 soil parameters (texture, humidity, and profile). Linking the soil map to an interpreted code table grouping soils by homogenous soil features enables the establishment of soil structures. Additionally visualising the

watercourses according to their category can show the structural effect of watercourses. The relief can be taken into account as well using a DTM (Digital Terrain Model)-file or by digitalising contour lines. When overlaying these files one obtains a map of the physical structure upon which valleys, depressions, dry higher grounds, etc. can be distinguished. This way, simple GIS-applications result into a basic map serving as point of departure for the further planning process. Diagram 2 illustrates this process.

Diagram 2. GIS-method to translate the physical structure

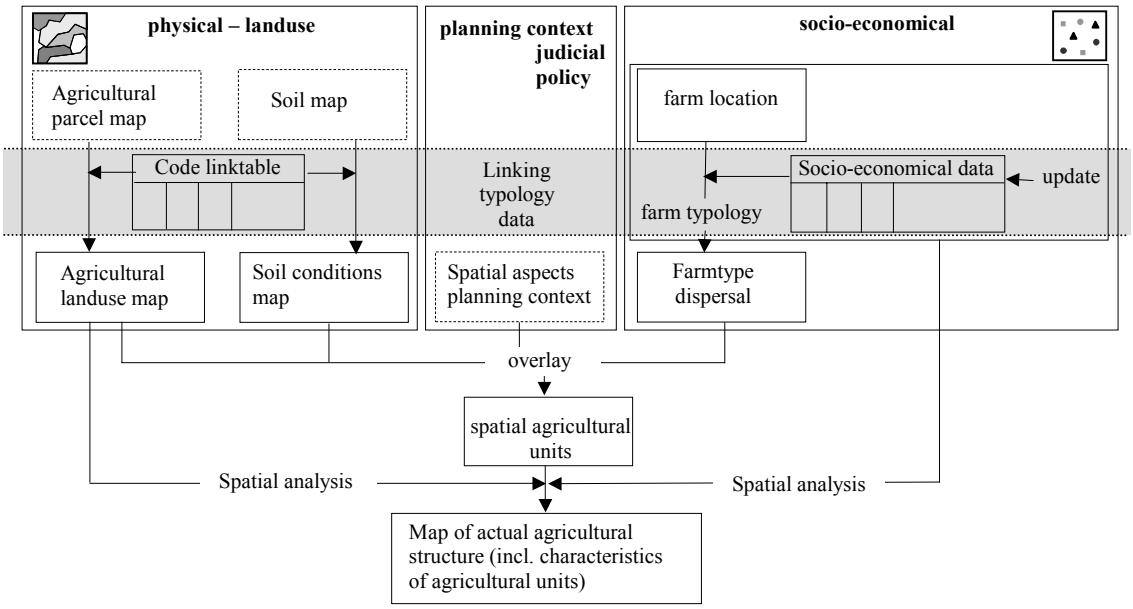


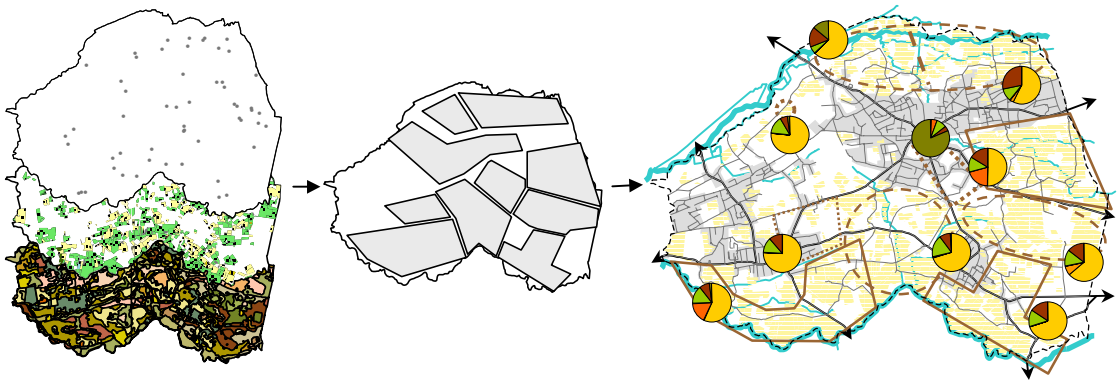
2.2.3 Case study Nijlen: GIS-translation of the 'existing agricultural structure'

A definition of the agricultural structure is found in the Spatial Structure Plan Flanders (RSV, 1997: 76): 'Agriculture is a structuring function for the open space. The importance of agriculture as a structuring function for the open space is shown by the scope, spatial spread and structure of the employment in the agricultural sector, the spatial spread and nature of farms and the farmed land surface, the scope and spatial spread of soil-dependence, the succession pattern, the dynamics and production structure'. When examining the agricultural structure the spatial-functional elements can be subdivided in three categories: physical land use, juridical planning context and socio-economic context. In the first category the basic files of the parcels for agricultural use and the soil maps are converted by means of data coding, linking to external data files and suited visualisation to interpreted and spatially relevant maps regarding the agricultural use and to soil suitability maps. Secondly, linking socio-economic data to localised farms and the application of a standardised farm typology enable to examine and visualise the geographical spread of farm types.

Overlaying these maps with the juridical context as a third gives sufficient information to proceed with the demarcation of spatial agricultural entities with uniform characteristics. These are then taken as basic material for the spatial analysis of socio-economic data and data regarding the agricultural use. This way, a simple GIS-application can result into a comprehensive spatial sector analysis. Diagram 3 illustrates this GIS-process.

Diagram 3. GIS-method to translate the existing agricultural structure





analysis and interpretation units spatial structure map

2.3 The use of GIS when developing a point of view

2.3.1 Determining the interactions between various partial structures through overlays

In partial structures the spatial relationship within a planning area is always considered from a specific, almost sectoral point of view. This approach is by definition a simplification of reality because these structures show strong, mutual interactions. An important step in the planning process is therefore the confrontation of the existing structures with one another. The use of overlays is essential here because this way one obtains an insight in the mutual interactions and in the conflicts and opportunities regarding the spatial composition of the planning area. The overlay technique is therefore indispensable as a step between an analysis per sector and the development of an overall perception, during which the desired development perspectives of the partial structures must be tuned to one another. Besides, the use of overlays enables the spatial planner to guide the political and social choices in view of a sustainable spatial use. The overlay technique makes use of field backgrounds (topographic map, land register map, orthophotograph,…), thematic maps (sector maps + juridical maps), interpretation maps and analysis maps. The number of overlays depends on the complexity of the planning area and differs per planning area.

2.3.2 Case study Nijlen: conflict analysis between the juridical land-use destination and the physical structure using an overlay

An interesting example is the overlay of the regional land-use destination plan (juridical map) and the physical structure (spatial interpretation map) to test the housing areas to the physical structure. This simple overlay reveals a major problem: when drawing up the land-use plans the major considerations were property structures and profit opportunities, whereas the physical structure was mostly ignored. The consequence is that wet parcels and (floodable) valley areas were indicated as housing area, whereas the importance of these grounds for water buffering and infiltration were underestimated. Which is a major cause for the flooding problems in Flanders. Through an overlay and a thematic query one can detect wet, undeveloped valley areas and depressions with housing destination. Subsequently, spatial conclusions and actions can be deducted, such as for instance the re-allocation of certain housing areas to a more suited function.

2.4 The use of GIS when presenting desirable spatial structures

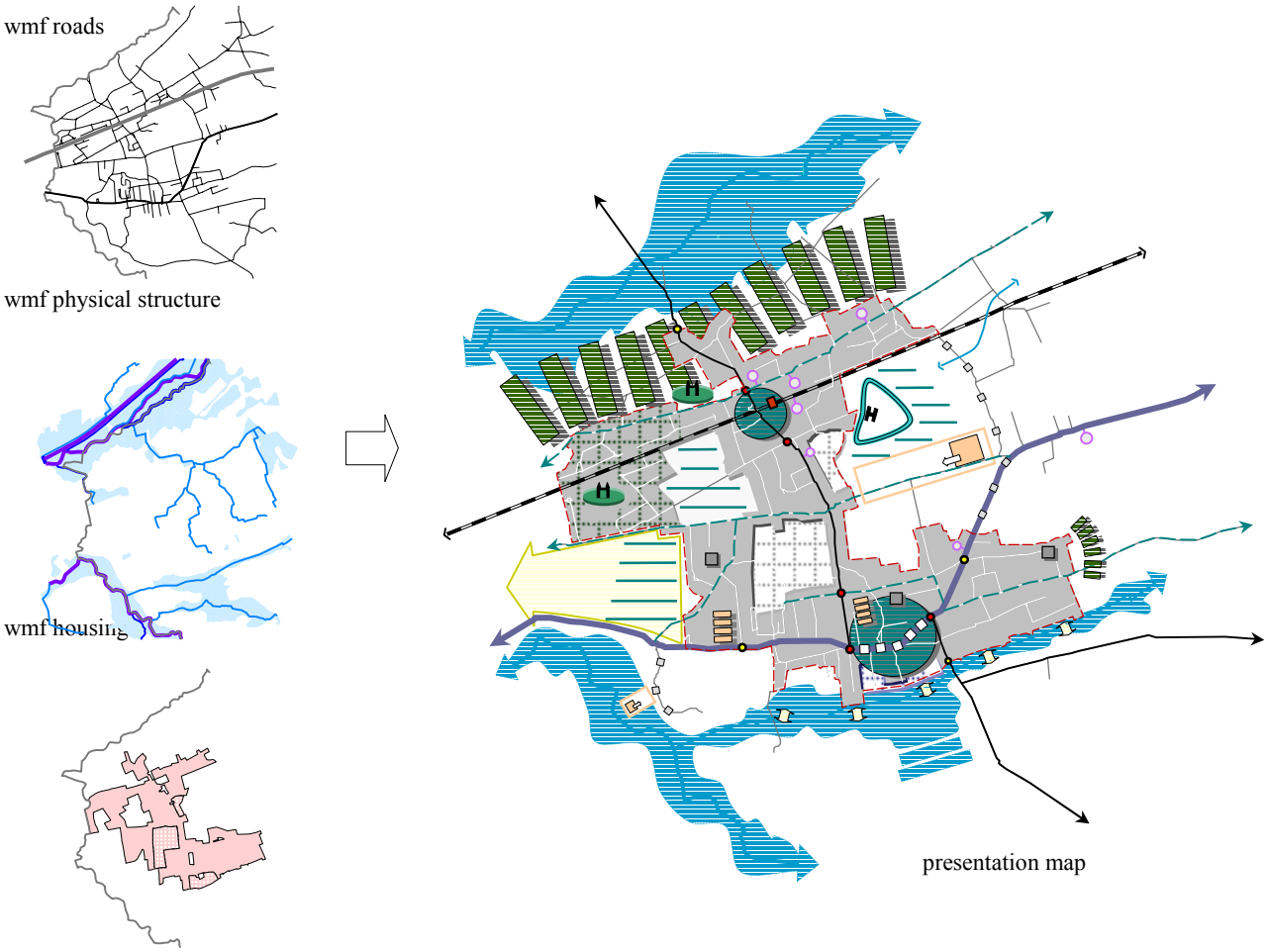
Existing structures and, even more so, presentations of desirable structures must be presented in a well-arranged and understandable way. The realisation of a spatial structure plan depends on broad social support, making comprehensible maps an important part of spatial planning. Because structure maps aim to show mainly structural wholes and functional relations, GIS is in many cases not really suited. One rather needs a presentation system that allows for graphical and operational flexibillity and working with a certain degree of geographical fading.

- Geographical flexibility is required because the spatial options are regularly polished in the course of the political decision-making and planning process, which makes it necessary that map corrections can be carried out fluently and rapidly.
- Operational flexibility is required because the desirable spatial structures must be explained graphically using general layout principles and concepts. The presentation system must enable rapid shifts from small to large scale and vice versa, using more or less details (structure maps ↔ concept drawings).
- Geographical fading is sometimes required to avoid that one will regard geographically accurate and digitally linked presentations of spatial entities as a land-use destination (even when leaving out the background), whereas it actually are broad, graphical interpretations of a spatial perception and the readability of the spatial idea has priority.

The following method is used: through a thematic query and overlay one can compose GIS-themes related to the adjustable items (road patterns, housing land, valleys, industrial estates, …) one considers required for the graphical presentation map. By exporting these GIS-themes as wmf-files (Windows metafile), we obtain graphically very flexible files that are easily adjustable in word-processing programmes (Microsoft Word, Wordperfect, …) or graphical drawing programmes (Illustrator, Photopaint, Coreldraw, …). Working with wmf-files also enables to create presentation maps without loosing the mutual geographical reference between partial structures. The planning team has chosen for a word-processing programme as it enables to integrate illustrations and concept drawings directly in text documents. The drawing tools within a number of these programmes offer sufficient graphical flexibility to process the wmf-data and to make rapidly structure maps, basic sketches and concept drawings; to enlarge/scale down and to group similar elements, to create transparant overlays, to copy/paste lay-out features, to fix the position of drawing objects when copying/pasting between documents, three-dimensional presentation tools, rotation, mirror image, etc.

The following structure map gives the desirable spatial structure of a subarea of Nijlen (a formerly independent municipality). To produce this map about 7 wmf-exports have been used, overlayed and graphically processed using the drawing tool of the word-processing programme. The result is a graphically flexible map, constructed with the required geographical fading and usable to ‘sell’ spatial ideals to the public.

Figure 1. From wmf-exports to presentation map



3 CONCLUSIONS AND RECOMMENDATIONS

The case study shows that GIS can in effect create surplus value in spatial structure planning. This surplus is situated in various fields, all with their own points of interest, opportunities and limitations: spatial data management, the analysis and combination of spatial data and the creation of presentation maps. Both for the analysis and presentation of existing spatial structures and for establishing spatial interactions and bottlenecks GIS is indispensable. The direct application of GIS-visualisations for the presentation of desirable spatial structures does not seem the best choice; however, GIS does offer useful support for creating such presentation maps through exporting GIS-objects as Windows metafiles.

The efficient use of GIS requires observing some organisational and logistic preconditions. A transparant and dynamic data management is essential, in which systematically for each file metadata with information on scale, accuracy, date, etc. are saved. To guarantee the employability of the digital spatial information a periodical update is required.

As for the organisational asspect, the application of GIS in spatial planning requires an optimal, well-organised interaction between the spatial planner and the GIS-expert. Then GIS is not a goal in itself but only a tool, in this case for the benefit of spatial planning. That's why it must be avoided that the distance between the GIS-expert and the spatial planner is too big. Drawing up interpreted maps, making overlays, etc. falls under the category of GIS-expertise, but must be fed from the spatial planning team. In turn, the spatial planner must have a kind of "GIS-reflex" in his seacrh for and gathering of spatial information. A good mutual communication is therefore recommended, yet often insufficient. It is recommended that both the spatial planner and the GIS-expert have at least some basic undestanding of each other's work domain and that GIS is embedded in the planning team. A proper approach can be that one or more spatial planners train themselves in GIS (interpretation and analyses, …), whereas the other planners restrict themselves to a GIS-reflex and its application.

The selection of the appropriate software is important, but remains subordinate to good data management. Considering the large number of manipulations with data of diverse origin involved in working with GIS, the "open nature" of GIS as compared to other programmes on the one and external information on the other is the most important criterion. Experience has learnt that one package rarely has all qualities needed, so that according to the nature of the activity involved (digitalisation, analysis, query, presentation, …) one can shift to other packages, be it GIS, CAD, data management programmes or word processing.

4 LITERATURE

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This paper came about with the cooperation of the members of IOK plangroep: Rhea Denissen, An Steegen, Filip Smits and Freek Van Looveren