

RasterPlan: A TOOL FOR DESIGN OF QUANTITATIVELY DEFINED SCENARIOS

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***Abstract:** By developing framework plans on a large scale such as a country or a region, planners use economic prognoses which show future needs for space for new spatial developments expressed in units of surfaces. Planners and designers make drawings and sketches to show where those new areas will be situated, but they do not really measure the surfaces of spaces they created. This often leads to incorrect images which can be wrongly understood by actors in decision making. To avoid this problem the Netherlands Institute for Spatial Research developed a mapmaking software called RasterPlan. The purpose of this tool is to make design decisions quantitatively checkable and transparent. The maps which result from the RasterPlan are precise in geographical positioning and defining the surfaces of designed areas. RasterPlan allows realization of a quantitative program for future spatial needs for various functions such as housing, working, green and water areas, and recreation. In addition to quantitative calculations, qualitative criteria for location choice can be also expressed in a form of suitability maps or buffers. This paper presents an experimental implementation of RasterPlan for the design of a scenario for the future development of the Province North Brabant.*

Key words: Map making, design tools, scenario design

1. Introduction

Creating maps is an essential activity in spatial planning. Often maps show predicted future developments visualized in the form of sketches or vague drawings. According to Monmonier (1996) as a “scale model” map represents selective, incomplete picture of reality, where symbols used are bigger and thicker than the characteristics they represent.

The power of these images is actually underestimated because they can have large influence on political decisions and public opinion. Vast majority of maps users trust the maps because, “as with many things beyond their full understanding, they readily entrust mapmaking to a priesthood of technically competent designers and drafters working for government agencies and commercial firms....Map users seldom, if ever, question these authorities, and they often fail to appreciate the map’s power as a tool of deliberate falsification or subtle propaganda” (Monmonier, 1996).

An example of such a map is the image of areas reserved for urbanization and national landscapes from the Fifth Act of Spatial Planning of the Netherlands. In this image, vertical grey lines show the areas which can be committed to urbanization. As the lines are dark and thick, they give the impression that large amount of the country will be completely built up, which is not what the text of the Act explains. Actually, the grey striped areas are only search zones within which some smaller areas will be developed as urban extensions. So, urbanization zones are only a framework for planning that will be later worked out by provincial or regional planning authorities.

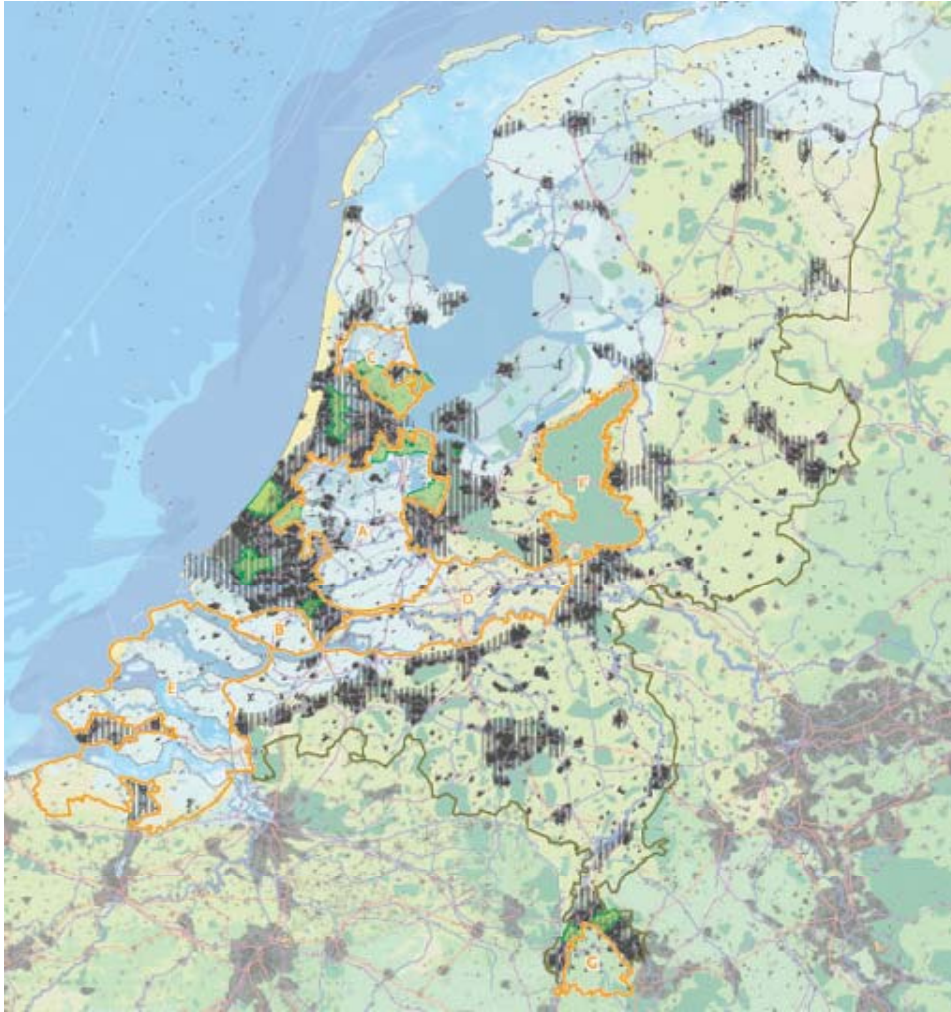


Figure 1. The Map of Urbanization Areas and National Landscapes from the Fifth Act of National Planning

As many participants in a planning process do not read the whole text of the plan, they assume that the images represent real plans, and do not realize that these images are just sketches. A sketch is never meant to be precise therefore when images have to show exact amount of space for future developments, other design techniques should be employed.

With the creation of Geographic Information Systems (GIS) techniques, many designers thought that GIS would be the solution to this problem. But although GIS is a powerful tool for spatial data collection and analyses, it is not frequently utilized in the design process. While the reasons for this are not the subject of this paper, we would like to mention the most important one—conceptually, GIS is a database and not a designing tool. The skills of a GIS specialist are different then those of a designer, and for that reason designers needs extra training to be able to draw in GIS. The strict logic of GIS is not fitting to designers' needs to quickly create sketches when needed. The complicated manner of drawing in GIS disturbs the flow of ideas pushing the design process from conceptual to technical aspects, which all together require more time and efforts than usual design techniques.

In the Netherlands Institute for Spatial Research, we often deal with predictions of future spatial developments expressed in quantitative needs for extension of housing, working, nature, water areas, or infrastructure. Therefore, we needed a simple tool which can be easily and quickly used to design realistic scenarios or alternative plans for future spatial developments. In order to accomplish this, the RasterPlan software was developed and implemented for an experimental design of a plan for the Province of North Brabant. The design of the plan was also conducted with two other methods Land Use Scanner (Ruimtescanner of The National

Institute of Public Health and the Environment - RVIM) and GIS based design method AGORA, developed by designers of our Institute. The three methods were then evaluated and compared. The emphasis of this paper is though on characteristics and potentials of the RasterPlan software.

2. Context of the RasterPlan and Its Relation To Other Similar Tools

Since the 1960s, there have been concerted efforts to make possible robust representation of spatial problems embodied in functional models of the spatial system. In its most extreme form, this perspective assumes that spatial problems can be represented within functional models, that formal processes enable such problems to be consistently resolved, and their solutions tested using such models (Batty et al., 1998). As a result, a large number of functional models have been developed throughout the world. Those models in many cases use automatic methods, such as cellular automata, logit or agent based algorithms, to allocate the functions. One of the most known Dutch models which uses logit model for allocation is Land Use Scanner, which will be described later in the text.

RasterPlan is though not a functional model. It belongs to the other group of tools which will in this text be called Computer Supported Design Methods (CSDM). The basic difference between CSDM and functional models is that CSDM do not use any algorithm for allocation - a designer or a group of designers decide where to allocate which function.

The aim of allocation models is to formalize planning process, which gives an impression that planning is conducted in a quasi-scientific manner. Unlike allocation models, CSDM enable users/actors themselves to design and choose the strategy they want when developing an area. However, this action of design is supported by quantitative and qualitative information. In that sense CSDM differ from other design techniques and are closer to functional models.

There are many CSDM systems developed nowadays; they differ in their goals, and they are applied in different settings. Some of the goals are:

- to make design transparent and controllable,
- to predict or control spatial developments,
- to manage spatial information needed for the design process,
- to develop plan alternatives,
- to evaluate the impacts of plan alternatives,
- to support design decisions,
- to support actors decision making, and
- to promote and stimulate collaborative planning process.

The web site www.PlaceMatters.com gives an overview of currently used systems which are partly allocation models and partly CSDM tools. After a quick scan of CSDM systems and in consultation with world wide planning support systems experts, it is came out that the most elaborate and the most popular ones are Community Viz, Urban Sim, Smart Growth Index (with Paint the Town as its known implementation), and PlaceIt. However, because all of these systems are either model based or GIS based and therefore not completely usable for the purposes of our Institute, we decided to develop our own tool.

3. RasterPlan Software

RasterPlan is a software which has been developed by the Netherlands Institute for Spatial Research in cooperation with the firm "Digital Architects." Unlike other types of software used for land use planning or allocation, RasterPlan does not rely on any kind of computational model such as cellular automata or similar algorithms. Instead, a designer or a planner decides where and in to which extent to allocate functions.

RasterPlan is programmed in Delphi language as a standalone application. This paper presents the first version of the software which was developed during the past year and has been used in one case study.

Technically, RasterPlan combines some basic GIS operations with simple drawing possibilities similar to those of Photoshop. It consists of three parts:

- a drawing section where raster images can be created,
- a calculations section which calculates land use changes, and
- a section that includes some simple GIS functions such as intersections and buffers.

The interface of RasterPlan looks partly like Photoshop (figure 2) and drawing functions work on similar way.

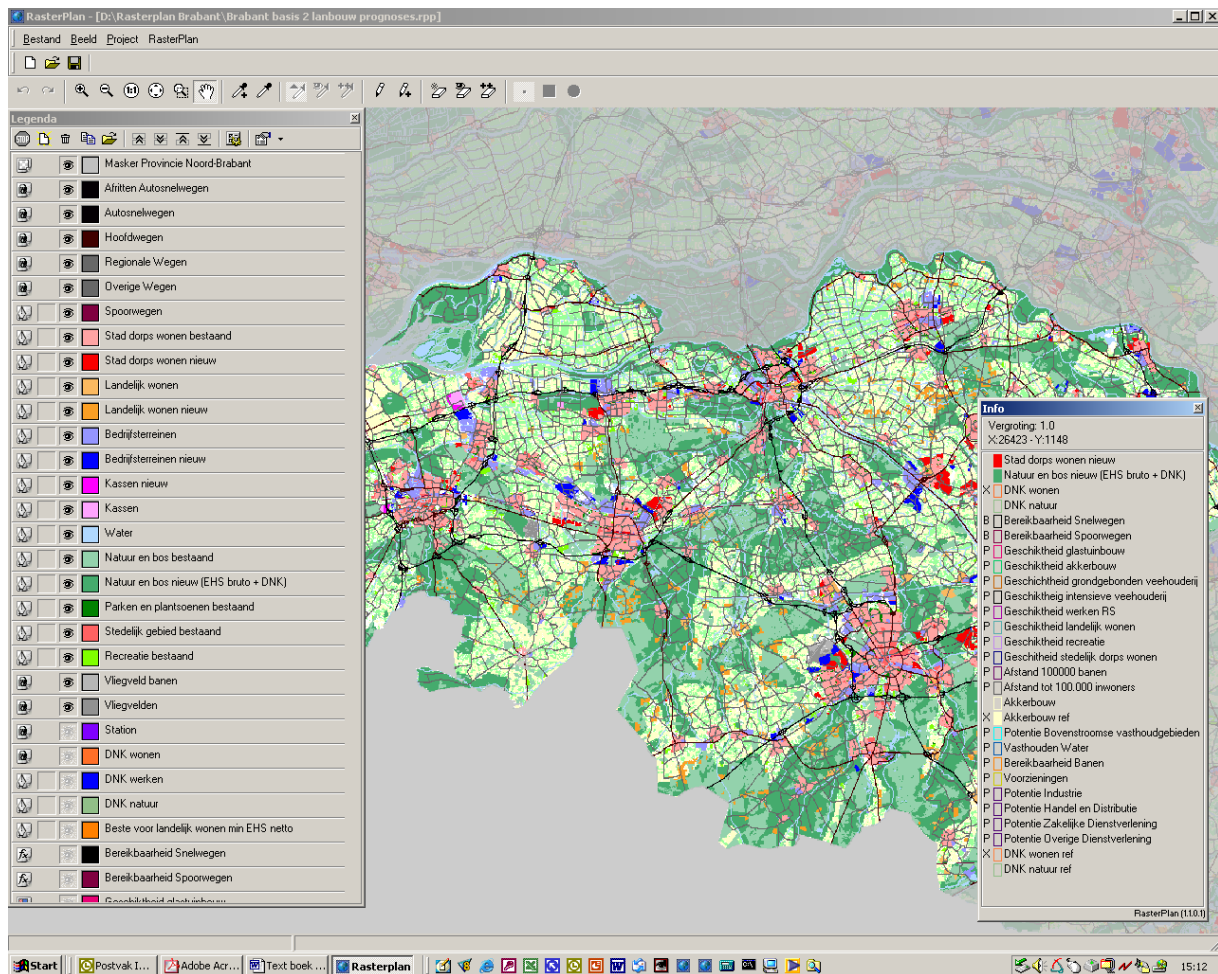


Figure 2. Interface of RasterPlan

As the name says, RasterPlan is a raster based drawing tool. The cell of the raster can be of different size, which is defined at the start up of a project. For the regional or state scale the proper size is 100 by 100 meters, 1ha. Cells of the map are the basis for all the calculations.

RasterPlan uses different kinds of maps and numeric data as input information. This data can originate from GIS and other software applications which can produce bitmap files. The maps are used as overlay information for spatial analyses, but suitability maps from functional models can also be imported and used as a reference for allocation.

RasterPlan combines drawing and calculation functions so that the sketch created can be quantitatively checked. The final product of this process is a map that shows the amounts and spatial distribution of new functions and a table that shows the changes in land use caused by this allocation. Such a map can be exported as bitmaps and used in other applications, while a table can be exported as an excel file.

As RasterPlan involves some features of GIS, it is also possible to perform qualitative analyses important for the choice of location for certain functions. For example, intersections and buffers functions can be used to produce usability maps or to find hotspots. Although technically it is possible to apply it to smaller scales, RasterPlan is designed for making large-scale scenarios, mostly on regional or above regional scale.

3.1 Implementation of RasterPlan on a Case Study of Province of North Brabant

Together with other two techniques – Land Use Scanner and AGORA, Raster Plan was used for the design of spatial development plan for the Province North Brabant. As a starting point for the design all three methods used a scenario study developed by Netherlands Institute for Spatial Research, Free University of Amsterdam (VU), Institute for Agricultural Economics (LEI-DLO), and The National Institute of Public Health and the Environment (RIVM). The scenario study was used to define quantitative and qualitative requirements for the spatial development of the Province.

There were two scenarios designed within the study. The scenario called “Individualistic World” was used for this experimental design. That scenario describes future developments in terms of quantitative program for new areas for housing, work, recreation, and glasshouses, which will replace agricultural land in the province. Next to the quantitative assignment, the scenario describes the main lines of spatial development. So, according to authors of the scenario, it is economic development which is the most important for the future of the Province, and everything that can contribute to economic progress is stimulated. The spatial consequence of such an approach is that more low density housing in attractive natural surroundings is needed. In the scenario the environment is only protected where it has high values, the rest is free for other functions. Agricultural production is represented by large and robust enterprises.

Table 1 shows the quantitative assignment used for the design with RasterPlan, Land Use Scanner and AGORA.

| Spatial function | Number of hectares |
|-------------------------|---------------------------|
| Housing in urban areas | 5780 |
| Housing in rural areas | 6898 |
| Working areas | 10272 |
| Gashouses | 99 |
| Nature | 105173 |
| Recreation | 3978 |
| Agriculture | -127366 |

Table 1. Quantitative assignment for the spatial development of the Province of North Brabant

As one of the aims of the research was to compare RasterPlan with Land Use Scanner, for the analyses and location choice a number of usability maps originating from the Land Use Scanner were used as analyses layers showing where is good and where not to allocate certain functions. Generally, RasterPlan is not dependent on data or usability maps of Land Use Scanner. It is possible to conduct own analyses by using GIS functions in RasterPlan. It was in this case more for the practical reasons and time limits that we have chosen to import the maps from Land Use Scanner. Additional to those usability maps other information sources were used, for instance the New Map of the Netherlands to allocate new housing and the map of Ecological Infrastructure of the Netherlands to develop new nature areas.

Figure 3 shows the methodology of use of RasterPlan for the design of the experimental plan. Figures 4 and 5 show the existing map and the planned situation of the Province North Brabant which are the result of this process.

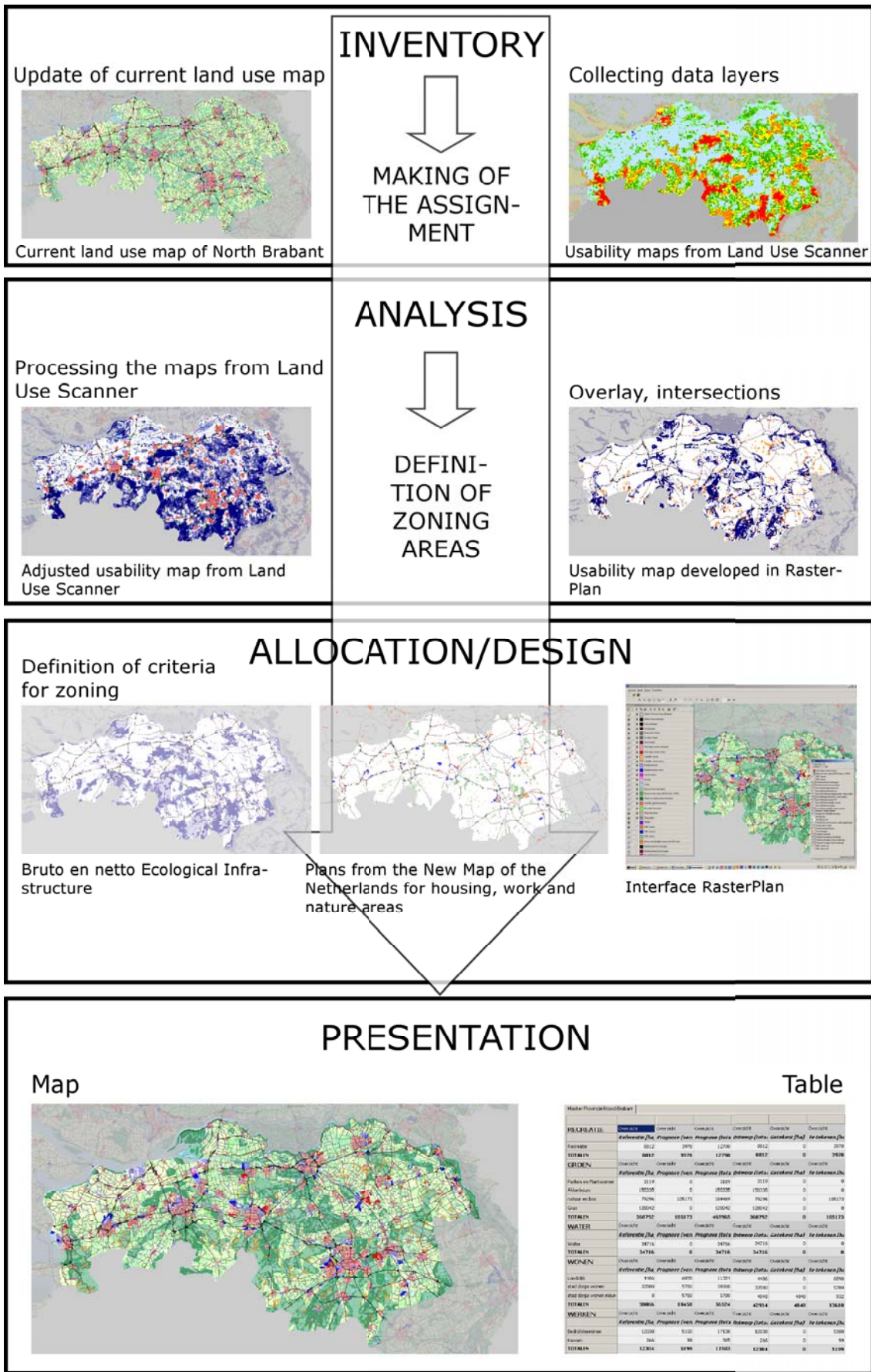


Figure 3. The methodology for the development of the spatial plan for the Province North Brabant.

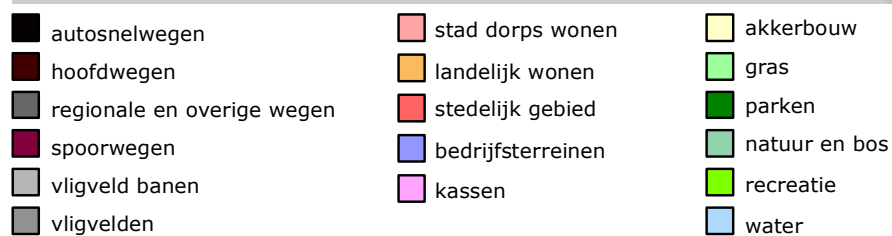
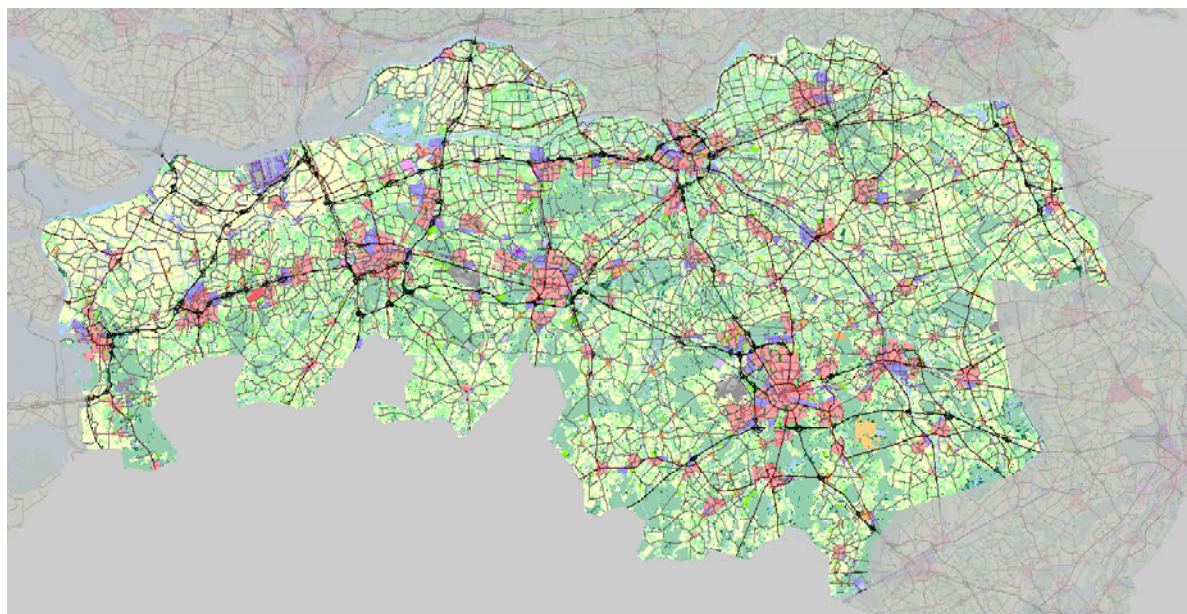


Figure 4. Map of the current land use in the Province of North Brabant made in RasterPlan

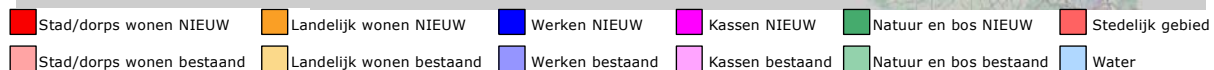
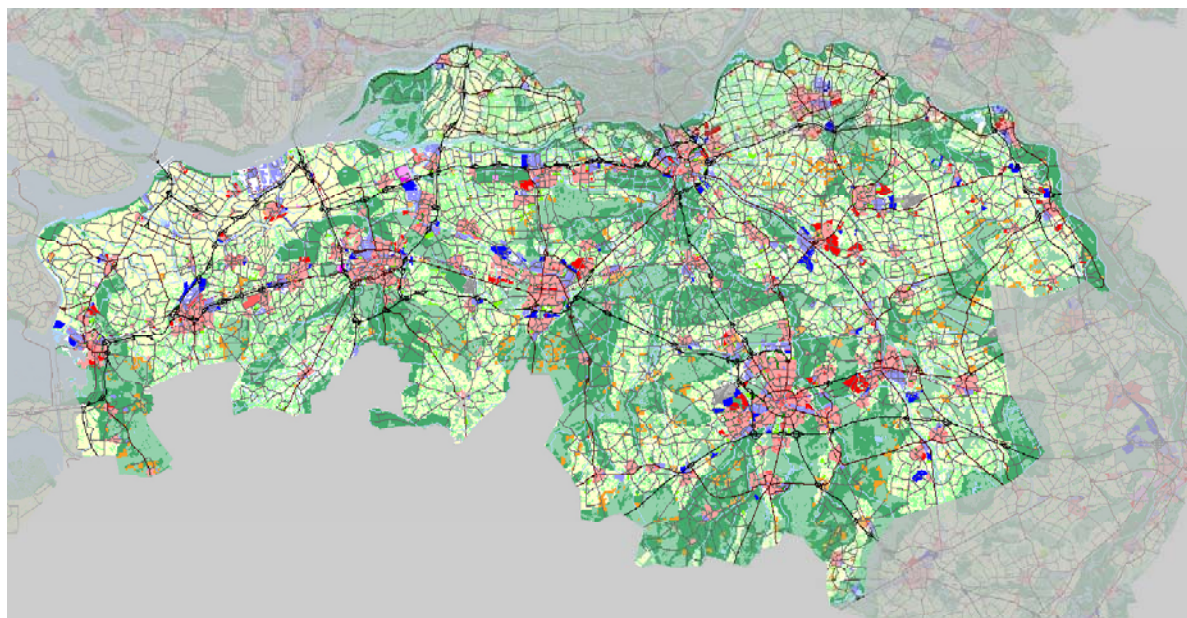


Figure 5. The result of the designing process with RasterPlan: The image of the spatial development of the Province of North Brabant till the year 2030. The grid cell is 100x100m; lighter colors represent current and darker colors future land use. To produce this plan the usability maps from Land Use Scanner were combined with national and local policy plans.

In this plan all the hectares required in the quantitative assignment (table 1) were realized. As a consequence the huge amount of agricultural land was converted to housing and nature areas.

The results of this experimental design are not meant as a definitive plan for the Province because design conducted with RasterPlan was in this case more oriented towards methodological aspects than to the content. Nevertheless, this exercise produced useful insights into a possible spatial development of the province if such a scenario as described above was to come true.

3.2 RasterPlan versus Land Use Scanner and AGORA

In this chapter we will describe other two methods which were also used for the allocation of the land use in the Province North Brabant: a functional model - the Land Use Scanner, and a design method named AGORA. Thereafter RasterPlan will be compared with these two methods.

The two methods were chosen for different reasons. The Land Use Scanner is the most known and used in the planning practice in the Netherlands, and AGORA relies on GIS and hence represents one more attempt to employ GIS in design.

The Land Use Scanner is a known method for land allocation invented by The National Institute of Public Health and the Environment (RIVM). According to its developers, the firm Object Vision, the Land Use Scanner (Ruimtescanner in Dutch) is a GIS based information system, calculating scenarios for future land use. A spatial allocation model, taken into account the current land use, the attractiveness for future land use and regional claims, is used to predict multiple views on future land use. The Land Use Scanner has been used for various spatial planning projects. It was amongst others applied for simulating the consequences of different planning perspectives and assessing the changes in land use caused by a possible new airport location (<http://www.objectvision.nl>). Figure 6 shows the result of allocation of land use in North Brabant which was conducted by Land Use Scanner.

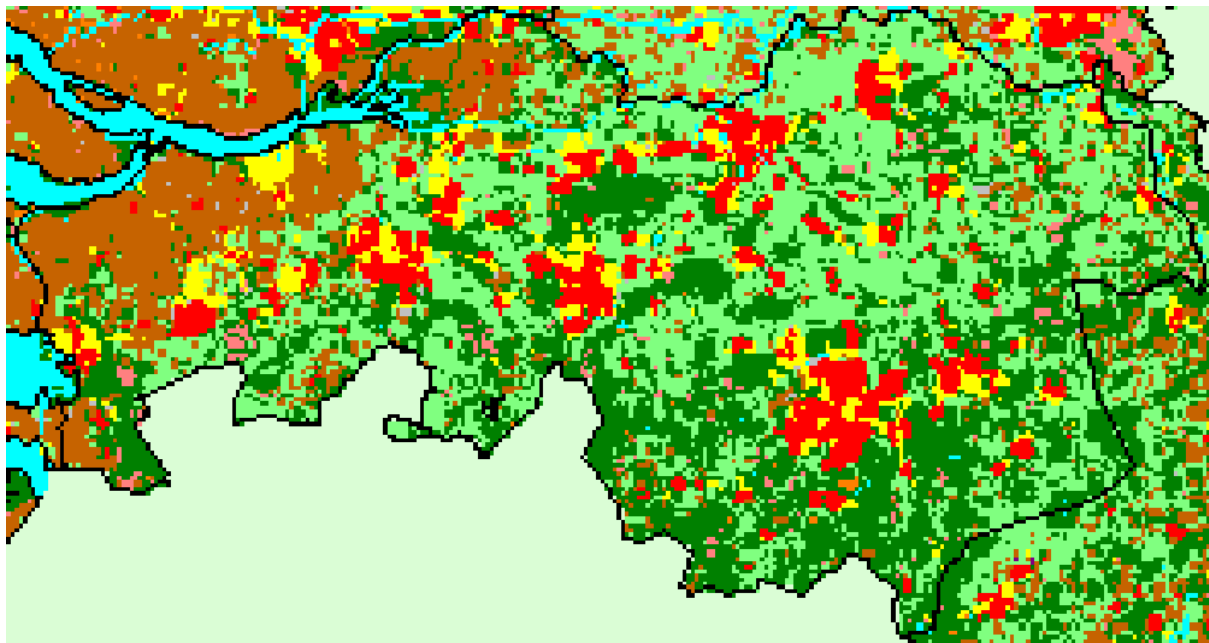


Figure 6. Future development of the Province North Brabant as a result of allocation by Land Use Scanner. Grid cell is 500x500m, only future land use is shown. The same usability maps were used for allocation as in RasterPlan.

AGORA stands for Analytic GIS-supported Spatial Allocation (Analytische GIS-Ondersteunde Ruimtelijke Allocatie). Basically it is a design technique which uses GIS for analyses but also for creating of future scenarios. In this case the ArcMap software was used to produce experimental plan for the Province North Brabant. Figure 7 shows the “plan” developed by two young urban designers by the means of ArcMap.

The table 2 shows similarities and differences between the three methods used. The table focuses on the most important criteria which were used to compare the three methods. There were also other criteria used but because of the lack of space they won't be considered in this article.

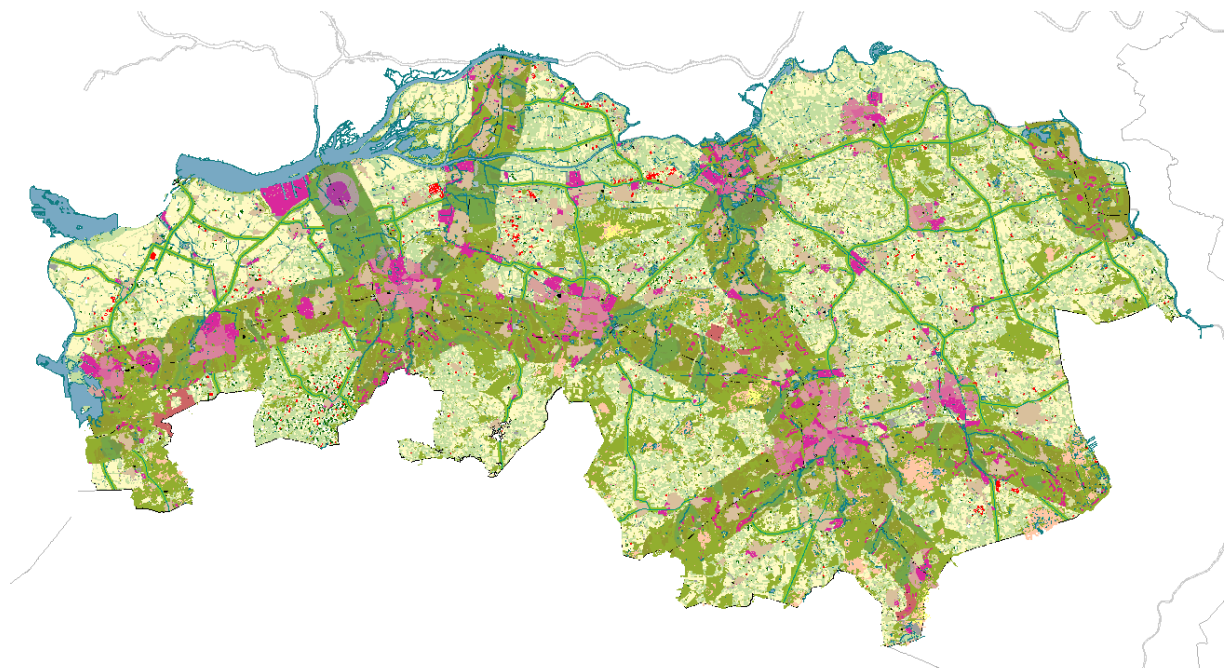


Figure 7. The plan for the Province North Brabant as a product of AGORA method. The vector drawing was produced in ArcView. The allocation is provoking and based on imagination rather than on realistic analyses.

| Criteria | Land Use Scanner | RasterPlan | AGORA |
|-----------------------------|---|--|--|
| Grid | 500x500m | 100x100m | vector |
| Cell | contains more functions | one function per cell, possible to pile functions | |
| Legend | limited number of units, defined beforehand | unlimited and flexible number of units | unlimited and flexible number of units |
| Spatial requirements | defined by prognoses/scenario's | defined by prognoses/scenario's | defined by prognoses/scenario's |
| Usability maps | produced by model, input criteria defined by user | taken from Land Use Scanner and combined with own analyses | own analyses |
| Current land use | basis for allocation, but not visible in the final product | basis for design and calculation of land use changes, visible in the final product | basis for design and calculation of land use changes, visible in the final product |
| Future land use | defined by allocation model | defined by designers in RasterPlan | defined by designers in ArcMap |
| Product | map and a table of future land use, various evaluation maps | map and a table of future land use | map and a table of future land use |

Table 2. Comparison of RasterPlan with Land Use Scanner and AGORA.

The three methods have a lot in common. The following similarities were found:

- The final products of all three methods are not predictions or plans.
- All three methods had as a goal to translate quantitative assignment of the scenario to plausible spatial images, and all three methods succeeded in that.
- The process of making of the maps was comparable because all methods went through the usual design steps: definition of spatial requirements, analyses, allocation, presentation and evaluation.

There are also considerable differences between the three methods. Those are:

- Land Use Scanner is an automatic method where creativity can be expressed only in the beginning of the analyses – by definition of usability criteria. By RasterPlan and AGORA creativity of the designer is present through almost whole process and employed in analyses, allocation and presentation phase.
- RasterPlan and AGORA can easily adjust to new and unpredicted situations, to new legend units and different spatial scales. Land Use Scanner is rather rigid in that sense.
- Allocation process of Land Use Scanner is better controllable and reproducible than the design processes in RasterPlan and AGORA.

Generally said Land Use Scanner attempts to simulate the process of change on more realistic manner, AGORA tends to create provoking solutions, while RasterPlan can achieve both.

3.3 Strong and Weak Points of RasterPlan

These initial experiments with RasterPlan highlighted many of its good points, as well as some weak points. Most of the weak points are of technical nature and occurred because the software was developed a very short time. So although we knew that it is possible to make everything we missed we had not enough time to do it. As this is the very first prototype, its further developments will easily eliminate these weaknesses.

The strong points of RasterPlan are:

- Design can be quantitatively tested.
- Images, which are the product of design, are realistic.
- Alternative scenarios or hypotheses for spatial development can be easily created and tested in RasterPlan.
- It can be used individually or in workshop settings.
- No knowledge of GIS is needed to operate RasterPlan.
- It is user friendly and easy to learn.

Weak points of RasterPlan are:

- If the grid cell is small and the area large, drawing takes a lot of time. To improve this additional drawing tools (polygon and paint bucket) can be added to the software.
- The resulting images are geo-referenced and precise, comparable with topographic map. If input data are not accurate, mistakes are very easily seen in the final design. Therefore RasterPlan needs good underlying maps of existing land use, and it requires good knowledge about the area in concern.
- RasterPlan is not proper for vague sketch planning.
- Software is in the development stage so it still needs some technical improvements.

4. Conclusions

RasterPlan is a Computer Supported Design Method which makes the design process transparent and quantitatively checkable. The maps which result from the design process are precise in geographical positioning and in surfaces of designed allocation areas. RasterPlan allows realization of a quantitative program for future spatial needs for various functions on regional or state level, such as housing, working, recreation, green and water areas as well as networks of infrastructure and connections. Next to quantitative calculations, qualitative criteria for allocation can be expressed too. For that purpose RasterPlan uses some basic GIS operation.

RasterPlan is geared towards professional designers and planners; it is user friendly and compatible with GIS systems. It can be used either individually or in group settings. The tool can be actively involved in direct planning process where different actors can express their preferences and immediately bring them on the map.

Finally, RasterPlan is not meant for all design purposes, and has no intention of replacing existing allocation models or sketch techniques. Rather, its purpose is to enrich the assortment of tools which can be used either alone or in combination with other tools, such as Land Use Scanner and AGORA, to enhance the planners performance and products.

5. References

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