Spatial data handling for urban and regional planning

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SPATIAL DATA HANDLING FOR URBAN AND REGIONAL PLANNING

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SPATIAL DATA HANDLING FOR URBAN AND REGIONAL PLANNING, DEMONSTRATED BY AN APPLICATION OF THE SPATIAL TRANSLATION MODEL PLOTBOROUGH

Summary

Among others the quantitative program of a structure plan contains statements about amounts of several kinds of land uses needed (planned) for the future. These planned land uses have to be allocated in the planning area of that structure plan. To find the most excellent places for every distinguished (planned) land use category the process of spatial translation is elaborated.

The model for spatial translation, named Plotborough, makes use of a main frame computer for calculations. Data are gathered by digitizing with the aid of a graphical tablet. The results are printed out and the spatial results are plotted.

To these results belong maps of the planning area, each of them showing the suitability for a certain relevant land use and maps with the allocations of the planned land uses, per stadium and in toto.

Next to the planning matter, in fact the whole process is a file handling and huge data handling exercise with several kinds of calculations. Digitized spatial data are elaborated for efficient use of storage

devices and are managed for further calculation (file handling). The next step implies plotting to see if the stored and worked data deliver correct maps.

In the model Plotborough calculations to transform subareas into grids follow. For each grid and for each relevant land use the suitabilities are ascertained. This being the case suitability maps are plotted.

At last the allocations take place with several interim

plottings. Grid data and allocation input data and statements are filed too.

The model Plotborough has been tested in so-called fictive situations as well as applicated in real planning ones. From the last mentioned kind we will describe the application for the structure plan Ede. The municipality Ede concerns one of the in area biggest municipalities in the Netherlands and is situated in the midst of the country, west of Arnhem. Its territory contains about 40,000 hectares· the structure plan was elaborated on this detailed level and counted 60,000 grids (40,000 hectares of Ede and 20,000 hectares of the adjacent municipalities of the surrounding of this municipality) for which information was gathered.

Introduction

There are several ways to start with working on a physical plan for an area. Of course, a first one can do it without governmental planning by which we get laisser-faire solutions. A second way is to fix reservations of land for future use; which areas will be used for each planned land use or plan-category is examined in a later stadium. A third approach begins with calculating the quantitative program of land uses needed at a certain future moment and it tries to find sufficient suitable place for that program within the planning area. The fourth one starts to ascertain the (most) excellent areas for several relevant land uses and delivers restrictions to the quantitative program of needed land uses. The last way is an intermediate solution between the third and the fourth one; in this case there is a mutual tuning to the contrast between wishes and possibilities.

However, the fourth approach is the most correct one from a methodological viewpoint. But, physical planning is a matter of give and take, a question of decision-making and political decision-taking. For that reason the fifth afore mentioned approach probably will be usage in practice.

Now we will point at the spatial translation model Plotborough. This model joins to the fourth and fifth approaches, that means that the model takes care for allocations of planned land uses, or plan-categories, at the most suitable places within the planning area under consideration.

To know that most suitable places the model uses several spatial data from maps. Next it calculates the suitabilities for each relevant plan-category with aid of information about relations between the characteristics.

The availibility of the subareas in the planning area is a next important threshold in the allocation process. What will be allocated, of course, depends of the quantitative program. How it will be allocated, amongst others it depends of the calculated suitabilities and priorities. At last the model takes care for plotting of the information (input) and of the results (output).

The model Plotborough uses computer hardware. This means that all information has to be elaborated and has to be stored for such use. Generally those workings implies a lot of file handling and file management. The model is not only a theoretical model, but is used in the physical planning practise also. In particular we will demonstrate this with the example of the structure plan for the municipality Ede.

Structure of the model

Because of the importance of plotting the spatial translation model got the name of Plotborough. The model has been based on simplicity and efficiency. The working process consists of a data gathering and a data using part. The quantitative program of in the future needed land uses is at our disposal and , in fact, it functions as a point of departure. The quantitative data are taken or generated from the surveys elaborated on behalf of the physical plan; the quantitative data are the results of that research. From that we know which plan-categories are relevant and in which amount we have to find place for them somewhere within in the planning area.

For each (sub-)area of the planning area under consideration the suitability for use by those plan-categories is determined on the base of characteristics of each area. Next the plan-categories undergo a spatial translation procedure by which they are allocated.

As said before, the model contains a working process split up into two parts:

1. a data gathering and preparing part.

The spatial information is gathered from maps about the planning area c.a. and the organizing of relevant spatial data. The spatial data consist of two kind of data. Firstly, there are data with a 'point' location, like a school in case we speak about a structure plan or regional plan; in this case we give an input of coordinates of that location. Secondly, there are data with an area reference, f.i. a forest or a settlement (both on the level of a structure plan; in case of a national plan a settlement would be assigned to the other category, i.c. the point location data).

The spatial data are treated in a special way. As a consequence of computerisation and the development of CAD-techniques special apparatus have been created, like drawing display terminals, plotters and digitizers (graphical tablets).

In particular the digitizers give good opportunities for transforming of spatial data from maps into computer storagable data.

Digitizing, if an adequate software module is at present, is a very easy way to get a database a computer can read and which data can be handled.

But digitizing is boaring and it does ask for a very precise and accurate way of working. Of course, all kinds of tricks are elaborated to help during the digitizing session. For example: by enlarging maps more details can be stored in a more exact way.

In our case we use a relatively simple digitizing program, called PLOTBOROUGH/READIN. This program has been developed about 1975, and since it have been changed, extended and accelerated. A lot of the extensions have to do with new survey questions and to get a more proper connection to other Plotborough software modules.

But even then there will be made 'mistakes' during digitizing sessions. For that reason we developed a module for repairing files with digitized data. PLOTBOROUGH/REPARATION takes care for this (Van der Meulen en Baas 1981). This software runs on a drawing display (storage tube) terminal like the already a little bit obsolete Tektronix 4012-4016; of course this software is usable on more recently manufactured Tektronix products too, but just for digitizing, Tektronix 4012-4016 suffit.

Till now one can say we completed the first stage of the working traject of the model Plotborough. In this stage we did store the needed information which functions as a part of the input for running the calculation modules of the model.

In the second stage of part one we prepare the calculations. It means we do the file handling. We arrange the files for input, we plot the input data as far as these are spatial data, we do calculations to transform polygon data into grid data, and we plot these grid transformed data into maps. Stages one and two form the first part of the approach of the spatial translation model.

Pro plan-category weights and thresholds concerning the characteristics of the area are fixed in aid of the continuation part. Also the plan stages and the priorities for allocation are determined.

2. a data using part.

At first, calculations take place in which the characteristics of the area are worked up in two distinct ways, namely as pure characteristics of the distinguishable sites and as characteristics of the situation of a distinguished site. From the site characteristics we get site qualifications; from the situation characteristics the qualities of the surrounding of the site are calculated. The result of both kinds of calculation is the whole of suitabilities for use of the sub-areas of the planning area by the plan-categories; that is to say, we obtain a queue of sites in terms of suitability from high to low pro plan-category. Sites with highest value for suitability get precedence by allocation. Of course, this is only the case if that site is available for allocation.

If it is necessary to make more than one suitability map for one plan-category depends of the necessity to work with alternatives in this stage.

Now it is relevant to discuss one of the possible ways to generate a suitability figure for a grid in case of any plan-category.

We choose for a relatively simple formula because of the fact physical planning is not only an occasion for physical planners and researchers, but also it is a part of political and public decision-making. This means that the public, the laymen, not specialized in the discipline of physical planning and related research must be, in a certain degree, capable to understand and follow the way in which choices within the formula are made.

The formula has been based upon 'weighted summation' and nears in this sense a planning method known as 'sieve analysis'. This implies several methodological difficulties. We will not discuss them here but we mention amongst others:

1. which factors (characteristics) are qualified to be relevant;

2. the summation of statistically different scaled factors;

3. the determination of the weights for each factor;

4. the determination of the thresholds for each factor above or beneath a certain value the factor generates exclusion;

5. the choice of the course of a factor, this means the factor has a continual or a discrete progress.

This part ends by the plotting of the map, the cartographic part of the plan. Between times the suitability maps pro plan-category have been plotted. Through here it is possible to follow the decisions taken during the process of allocation.

Also there are methodological difficulties in case of allocation. We do not discuss them either, but we mention:

1. the sequential allocation because we use a sequentially working computer;

2. the staging in the (quantitative) program;

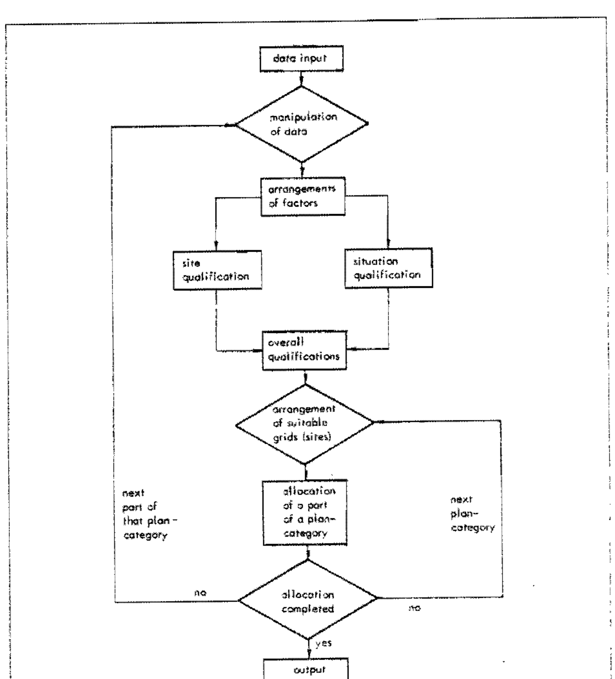
3. the prioriting of the allocation of the plan-categories;

4. the use of grids as working units;

5. ex ante evaluation (in particular a task of the physical planner as a researcher);

6. ex post evaluation (in particular a task of the physical planner as a designer).

The working process consists of a series of routines (procedures or modules) as is shown in the next scheme.



scheme 5: flow-chart of the plotborough model

The example: Structure plan Ede

In the midst of the Netherlands we find the municipality Ede. It counts about 90,000 inhabitants at this moment. However, Ede is a relatively huge municipality as far as its area is under consideration. Within its borders Ede has about 40,000 hectares of land. The municipality consists of eight settlements, namely: Ede (about 50,000 inhabitants), Bennekom, Lunteren (about 12,000 inhabitants), Ederveen, Harskam, Wekerom and Otterloo (about 2,500 inhabitants). Ede knows within its borders some special subareas like the royal domains and several militairy used terrains with buildings (barracks) and without buildings (among them are terrains with double functions, i.e. for public recreational facilities in the weekends).

On behalf of the structure plan for the community of Ede about 60,000 hectares have been viewed, namely about 20,000 hectares from the surrounding municipalities of Ede also. Together they cover a rectangular area with Ede in the center.

Generally the elaborated information has been gathered for those 60,000 hectares; principally the aggregation level of the data was a hectare. Relevant maps have been digitized; it means that recognizable polygons on the maps have been registered.

Next, the polygon based data have been manipulated, filed, elaborated and transferred by calculations into grids of a hectare each (with four characteristics assignable).

The quantitative program contained amongst others the next plan-categories:

1. housing: 14.2 hectares village housing, 49.0 hectares suburban housing and 221.5 hectares urban housing;

2. working areas: 159.4 hectares clean industrial area;

3. sports: 27.7 hectares open air sport facilities; and,

4. recreation: 90.0 hectares open air recreational facilities for daily use.

In general these plan-categories have been meant for own needs of the municipality Ede. The program has split up in three stages of ten year:

1. 1980-1990: with already existing thougts about spatial policy for the near future;

2. 1990-2000: for this structure plan the real allocating stadium; and,

3. 2000-2010: a forward looking stage with the objective to be 'warned' for later consequencies of choosen spatial solutions in an earlier stadium.

In the situation of the structure plan Ede the model Plotborough has been used as an intervening method to help in local discussions about the future physical planning. The method has to be seen as a form of research in which (about) eleven alternatives of the structure plan has been elaborated.

On behalf of the spatial translation of the quantitative program two kinds of data have been used, namely·

1. data related to the site itself, site characteristics, f.i. land price, land ownership, bearing power; and,

2. data about distances and influences from the environment of the site, situation characters, f.i. shop, school, road, housing area as positive ones, and high density road, dirty industry, bio-industry, and air field noise as negative ones.

In toto 36 situation characteristics and 10 site characteristics were used. With these characteristics the suitabilities has been calculated by means of weighted summation and collection approaches by in- or excluding.

The weights for the relevant characteristics probably differs for each planned land use as well as for each characteristic mutually. It is very difficult to reach a well elaborated methodology for ascertaining those weights. Normally they will be implicit; but using a computer you have to make them explicit. As a methodological start we asked experts as well as members of the municipal council to fill in a questionnaire. At first, the questionnaire consisted of an explanation about the structure plan and our way of working. Secondly, it consisted of a list of definitions about the planned land uses and a long list of site and situation characteristics. Thirdly, the questionnaire contained the filling-in part; the respondents had to do three things for each planned land use:

1. to choose the relevant characteristics; of course, there was an opportunity to enlarge the list of characteristics;

2. to order the relevant characteristics in two lists, namely for the site characteristics as well as for the sn characteristics; and,

3. to indicate the degree of importance of each characteristic in comparison to the other ones.

The results have been elaborated and they showed some interesting features. For instance, we could make quantitative (statistical) distinctions between some groups of respondents; the most expressed difference we calculated was that between the experts and the members of the council.

A special subpart of the calculations is formed by:

1. the availability of the areas within the planning area; and,

2. the thresholds, which means that above or beneath certain values of characteristics the site does not fit for allocation of a land use at all.

As a result of the calculations we know the suitabilities: for each planned land use maps are plotted.

In terms of planning and design they are very important because of the fact the computer does only work sequentially.

Following the program of the plan (staging and priorities) it means that already occupated areas by assigning a planned land use is not available any more; in some cases such areas may be the most suitable areas for a planned land use in a later moment of the allocation process.

In fact we have to do with files (or matrices) in which for each distinguished area (in our case grids of one hectare) we have values of suitabilities for each plan-category at our disposal.

The following allocation process is relatively simple; it is a question of assigning. The sequence of assigning depends of the staging and priorities from the quantitative program.

Lastly, the allocation results are plotted; at the end of each program-stage this happens also.

The quantitative program consists of amounts of hectares for the planned land uses. The allocation process knows three approaches. The first one assigns hectares sequentially. The second one assigns contingents of hectares; in this case it is necessary to search for areas in which the total amount of hectares, i.e. the total contingent, can be assigned as a whole. The result is an allocation with mutually adjacent hectares of the same planned land use.

The third approach accepts some fixed assignments as input; we implemented this approach because of already existing spatial policies for certain areas as well as to have a steering possibility for adapted elaborations.

In general after each allocation step recalculations of the site and situation circumstances of the planning area, i.e. for each grid, have been taken place. So we get a refreshed filling-in of files and matrices, describing the spatial actuality during the spatial translation process. It will be clear that the first afore mentioned approach is an expensive one.

General results of the application of the spatial translation model Plotborough is a series of files. At one hand it concerns files of the type plot-files; they will be plotted on a drumplotter or on an electrostatic plotter. It concerns files in which maps are stored: maps about the suitabilities and maps with allocation results.

At the other hand the application delivers extensive files with data from (interactive) input as well as from output; this is important for later runs.

The application delivers a wide insight in the consequences of putting forward conditions about priorities, staging, thresholds, availabilities and weights in relation to alternative quantitative programs.

Conclusions

The spatial translation model shows an explicit way of physical planning. The computer helps us to do routine elaborations; it does this better and quicker than we can realize it by hand. Storage and file handling form the fundament for this approach.

Planning and computerisation have been combined in the model Plotborough. At first, the model appeared to be ready to do a relatively huge job, i.e. file handling for 60,000 (40,000) grids of a hectare each. Secondly, it works with an extensive range of characteristics; they have been gathered, digitized, stored, manipulated and elaborated. Thirdly, all kinds of repeated calculations asked for special file management and memory organization. At last, mapping by plotting showed to be a worthful proceeding, in particular because of the amount of maps that will be created during the spatial translation process.

It appeared to be an interesting research tool for planners also. The rapidity in which new alternatives can be calculated and worked out in plotted maps is an important feature in this respect.

The model does not have meaning for the physical planning of a municipal structure plan only. It is useful for the physical planning at the regional and national level as well. The same is valid for physical planning in the developed countries as well as developing countries of the so-called Third World (Van der Meulen 1983a, 1983b, 1983c).

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