TOPOGRAPHIC BASE MAPS FOR PHYSICAL PLANNING MAPS: USER RESEARCH FOR GENERALIZATION

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ABSTRACT:

Because of the limited space in densely populated the Netherlands, careful land use planning, incorporating the views of all stakeholders, is of utmost importance. Dutch law recognizes two types of physical plan: structure plans and land use plans. A land use plan has a legal status and indicates what is (not) allowed on a parcel of land, whereas a structure plan is only indicative for possible future land use development. Map displays play an important role in the communication of physical planning information and since only recently the Dutch law prescribes that physical planning maps should be digital (instead of printed on paper). Therefore, physical planning maps will increasingly become available in digital, interactive, dynamic and exchangeable format for consultation by various user groups in a national web portal. Physical planning maps cannot do without a topographic base. As in many other thematic mapping applications use is often made of already existing base map layers, but, ideally, the topographic base should be better adjusted to purpose and use, scale of representation and the planning information layer that is projected on it. This can be obtained by good map design, but particularly also by an appropriate systematic cartographic generalization, based on the intended use of the map. This paper describes two user research projects (focus group and on-line survey) that were executed in the framework of a larger investigation of the automatic generalization of base maps for physical planning maps. The results of the user research can be used for steering a possible automatic generalization process, starting from an existing topographic database. Examples are a priority listing for the selection of elements of the topographic base of different physical planning maps at different resolutions and directions for mutual harmonization with the cartographic elements of the planning information layer.

1. INTRODUCTION

Physical planning maps play an important role in the realization of land use plans, but also in the communication of information about what is and what is not allowed in geographical space or on specific land parcels. For a long time, the Netherlands stuck to the production of physical planning maps on paper, but since this year 2010, according to the new Land Use Planning Act, a land use plan needs to be laid down in electronic and paper formats simultaneously. The digital contents are now even decisive in case of any difference and lawyers and judges will have to get used to that. The change-over from paper to digital is a logical step, particularly when the Internet medium is called in, because all users will really profit from this. After all, the transfer of physical planning information becomes easier ánd better in an interactive and dynamic environment like RO-online, the new geo-portal for physical planning information in the Netherlands (URL1).

Physical planning maps consist of a topographic base map on which a layer with plan information (usually in colour) is projected. In the past few years, in the project *Generation and use of base maps for integrated querying of digital physical development plans* (research project code RGI-002) research has been executed into the cartographic generalization of topographic base maps in combination with physical plans, notably for the benefit of online consultation and analysis. In a topographic base map not all details of geographic reality can and should be represented, particularly not as a user is zooming out. For this reason, cartographic generalization is always required. Such generalization is aiming at a simplification of the cartographic representation of geographic data, in compliance with the purpose and scale of a map display.

Hitherto, in the Netherlands, there has been no systematic thinking about the use of topographic bases for physical planning maps: usually existing maps were and are applied, like the large scale base map of the Netherlands (GBKN), the cadastral map, topographic maps on different scales or home-made multi-purpose base maps. The disadvantage of these existing map materials is that they were not produced in view of the function of topographic base map for physical planning maps. However, modern technology now offers starting points for the automatic generation and generalization of topographic base maps of physical planning maps from a geographic database, driven by function, purpose of use and user requirements. The technical aspects of this problem were

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investigated by another team in the RGI-002 research project (see e.g. Foerster et al., 2008 and Foerster, 2010) but in this paper we will pay attention to the initial user research that was required.

2. MAPS WITH TWO LAYERS

Map displays that are meant to give access to information about a particular theme - like physical planning maps (see Figure 1) - consist of a primary thematic information layer, for instance a layer with information about planned land uses, that is projected onto a topographic base. In this case, such topographic base maps have two functions:

- they allow the map user and the map producer to *localize* the thematic information (where is that?)
- they help to *explain* the geographic distribution of the thematic information (why is that there?)

In addition, for the purpose of a physical planning map the user will have to be able to see the difference between current reality and the plan information to discover, for instance, possibilities for new development.

Figure 1. Example of a physical planning map with two layers: primary plan information, projected onto a topographic base map

The degree to which the topographic base maps accomplish these functions does not only influence the quality of the answers the users get to their geographic questions, but also the quality of the decisions they take on the basis of these answers. Ideally, the nature and contents of the topographic base maps should be adjusted to:

- the purpose of the map as a whole
- the information needs of the users
- the scale of representation of the map display
- the primary information layer

In practice, it is quite a job to tune these requirements to each other. As a rule, users want to see as much information represented in a base map as possible; invariably every citizen is looking for his or her own house. But this does not always fit in with the purpose of the map. In a first global sketch of the possible geographic lay-out of an area (structure plan) a base map which is too detailed will perhaps lead to unnecessary heated reactions of the stakeholders, whereas the land use boundaries have not been fixed by a long way. But if the boundaries are already defined, as in a land use plan, a detailed ánd accurate base map would indeed be desirable in view of its function. How accurate and detailed the topography may be represented also depends, naturally, on the scale of the map display. On a smaller scale (e.g. 1 : 100,000) more has to be left out and simplified with the help of cartographic generalization operators than at a larger scale (e.g. 1 : 1,000). Besides, the base map should be adjusted to the contents and accuracy of the primary thematic information layer and this is often not done. In practice, most of the times for the base use is made of existing and available map materials that are often not produced in view of the function of topographic base map. For example differences in accuracy and up-to-datedness or in the mutual fitting of the map layers will then lead to problems of use and wrong interpretations. Those problems especially occur if the base map that has been used for the compilation of a primary information layer differs from the base map that is visible during the consultation of the final map display, as may be the case in a web portal.

3. LIMITATION TO TWO USE CASE SCENARIOS

The overall aim of the RGI-002 research project was to find solutions for the automatic generation and generalization of topographic base maps that meet the requirements of purpose and use (as described in Section 2) from a large scale database (use driven automatic generalization). The problem of topographic base maps for physical planning maps was formulated in the framework of the former so-called DURP project (Digital Exchange of Physical Development Plans) of the Dutch Ministry of Housing, Spatial Planning and the Environment (VROM). In order to be able to investigate the problem we limited us to only two types of physical plans that are distinguished in the new Land Use Planning Act: *structure plans* and *land use plans*.

A structure plan (in Dutch “structuurvisie” – structure vision) contains the principal traits of the planned development of an area, as well as the essentials of the policies to be executed by the municipal, provincial and national governments. A land use

plan (in Dutch "bestemmingsplan") designates the intended use of the land in the plan area and contains rules and regulations with respect to that intended land use. As a rule, and in a geometric sense, a structure plan map is *indicative*, whereas a land use plan map is *legally binding.* In addition, in our research we limited ourselves to only two government levels (province and municipality) and all this led to two use case scenarios (see Figure 2).

In *Scenario 1* the user compares the structure plan maps of provinces and municipalities. Think of a municipal planner who designs a physical development plan for a part of the municipality that should fit into the physical planning policies of the government at a higher level in the hierarchy (the province). In this case, the required cartographic generalization is a consequence of scale change. This scenario also represents the desire to zoom in and to zoom out, in order to obtain detailed insight and overview respectively. It is true that, in principle, geodata processing in a digital object-oriented environment is scaleless, but, of course, the scale of representation of a map display presented to the end user remains important for the transfer of information and that representation scale changes when zooming in and out.
In *Scenario 2* the structure plan maps of a municipality are compared with land use plan maps. The representation scale of both maps is the same, but there is a question of different generalization of the topographic base maps as a consequence of different map purposes.

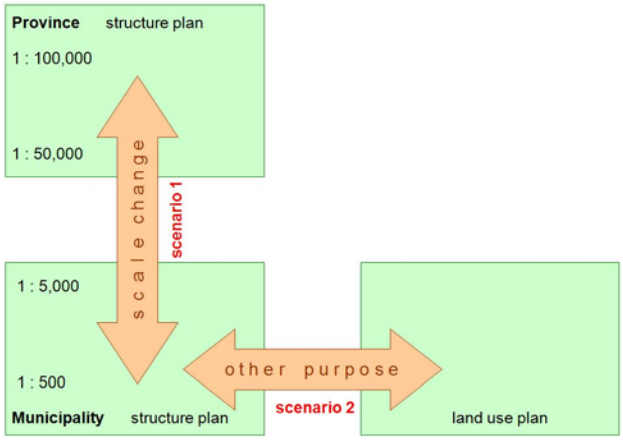

Figure 2. The two use case scenarios as distinguished in the RGI-002 project

4. USER RESEARCH METHODOLOGY

First of all, it appeared to be necessary to obtain – through user research – a better insight into the purpose and use of physical planning maps in the Netherlands, and particularly into the topographic base maps of these physical planning maps.
The user research consisted of several components: a study of current practices, for instance through document studies, a Focus Group meeting and an online survey.

Figure 3. Participants in the Focus Group meeting

The Focus Group meeting was held during a Government & ICT trade fair, which took place in Utrecht, the Netherlands (see Figure 3). The meeting was attended by 9 experts who had experience with working with physical planning maps and was recorded on video.The outcomes of the meeting were used for the formulation of concrete questions that were combined into an online survey that was opened during a NedGraphics study day and remained open for a period of 4 months. During those 4 months there were calls for participation on several occasions (Dutch conferences etc.) as well as through websites and written invitations were sent to employees of physical planning departments of municipalities and provinces and of (commercial) town and country planning companies. In the end, the total number of respondents was 112 and 35 of those 112 people did not complete the survey. Apparently, they had difficulties with answering the questions or the issue was too remote for them. For most of the others it was possible to complete the online survey, consisting of 51 questions including quite a number of map samples, within half an hour. More than half of the respondents made use of land use plans at least once a week and usually every day. They mainly did that in their function of municipal civil servant. This also applied for structure plans, but the use of those plans was far less frequent and mostly limited to a couple of times per year only. For the interpretation of the outcomes it has to be taken into account that there were hardly any 'ordinary citizens' among the respondents.

5. CURRENT USE OF BASE MAPS

In the past two years, 74 respondents had actually been involved with the production of land use plan maps, 51 of them often or always. The figures for structure plan maps are much lower: 37 and 7 respectively. All these persons were asked to indicate on the basis of which base maps they produced the physical planning maps. The outcomes are shown in Figures 4 and 5.

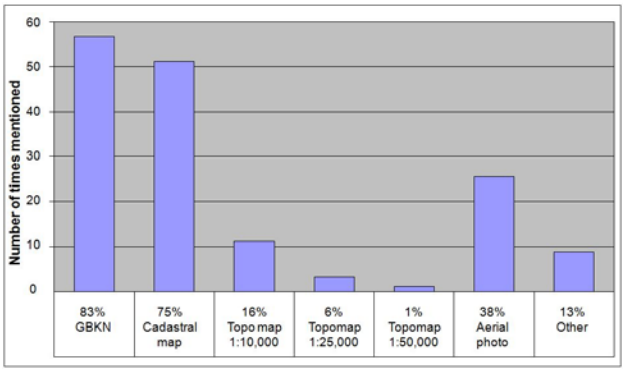

Figure 4. On the basis of which base maps are land use plans made in the Netherlands?

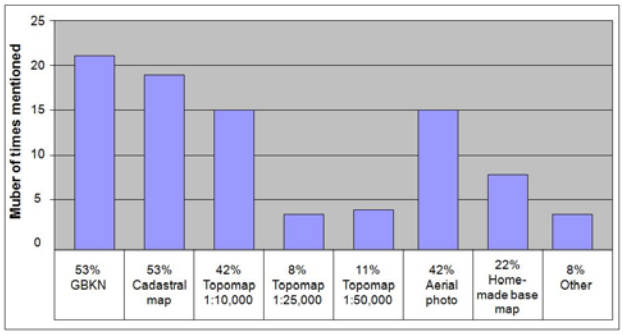

Figure 5. On the basis of which base maps are municipal structure plans made in the Netherlands?

The dominance of the GBKN (official large scale base map of the Netherlands) and of the cadastral map is evident with the land use plans and also logical in view of the scale of the land use plan maps which is usually somewhere between 1 : 500 and 1 : 5,000. It is striking that for the production of land use plans still a lot of use is made as well of aerial photographs. As also appears from the comments made in relation with one of the questions, this has to do with the fact that one third of the respondents is of the opinion that the employed map materials do not completely satisfy: it is insufficiently accurate, insufficiently up to date, or both. Therefore, for example, although the purpose of a land use plan asks for showing them during map consultation, often the cadastral boundaries are left out from the topographic base map because of those mistakes. In the interpretation of Figure 5 it has to be taken into account that the respondents have experience almost exclusively with the production of structure plans by municipalities. Looked at in that light, as well as in view of the deviant objective of structure plans, it is not surprising that aerial photographs and topographic maps at scale 1 : 10,000 are playing a bigger role here.

The respondents were also asked whether in the past two years they had actually been involved with the production of land use plan maps and structure plan maps (for presentation to the citizens). For this, in 70% of the cases use is made of exactly the same base map as that which was used in producing the plans. Hardly any, or no use at all is made of another base map, but in about 25% of all cases the base map is adjusted (graphically, or by leaving out elements) in order to increase the legibility.

6. MAP SAMPLES

In the online survey, about 10 fragments of existing land use plan maps and structure plan maps were presented to the respondents. In those map fragments different solutions were chosen for the nature and contents of the topographic base maps. The most important conclusions that could be derived from the reactions to the survey questions are:

- The respondents arrived at the conclusion that a combination of the GBKN with the cadastral map was the most suitable existing base map for land use plan maps. Clearly, a separate cadastral map or GBKN was considered less suitable and only 5% of the respondents considered an aerial photograph suitable as topographic base.
- Somewhat more respondents did consider an aerial photograph suitable as topographic base for a structure plan map, but still this percentage was only 20%. In that respect, almost 60% of the respondents applauded a map fragment with a topographic base map produced by the province itself.
- It was striking that three out of four respondents considered a topographic map at scale 1 : 25,000 suitable as base map for a structure plan at that scale, despite the big difference in accuracy between the base map and the primary information layer. However, probably the latter problem was ‘covered up’ by the attractive cartographic design of this map fragment. In any case, with the analysis of the results it became clear that the cartographic design of the various map fragments played a big role in the judgement of the degree of suitability of the applied base maps. For example, sometimes the base map was too dominant and in other cases not enough visible. The conclusion is that, next to a proper generalization, careful attention should be paid to the cartographic design of a physical planning map as well.
- With both the map samples of land use plans and structure plans mention was made often of the problem of the mutual adjustment of the representation of the topographic base and that of the primary (plan) information (see Figure 6). There are two aspects of this problem:
    - Sometimes there is a bad fitting (for instance because the GBKN has not been used for the production of a physical planning map, but is represented in the base of such a map display).

- In the design of the map there is an insufficient graphical distinction between the topographic base map and the primary information layer with plan information. The customary cartographic solution in which the base map details are shown in a neutral colour (grey, for example) and the primary information by means of different colours on top of that was not always applied.

Figure 6. Example of a fragment of an existing land use plan map, as presented in the online survey. Respondents reported the problems of the mutual fitting of the GBKN with the cadastral map and with the plan information, as well as the problems of the graphic distinction between the base map and the primary information layer.

7. USE AND USER TASKS

Among other things, the Focus Group meeting was used to find support for and create a basis for the matrix of user groups and use tasks that is presented in Figure 7. This matrix has been drawn up because there is a great variety of roles and tasks in the use of physical planning maps. That variety has to be taken into account in generalization and cartographic design. This may lead to the generation of different map displays for the execution of different tasks.

The use tasks that are listed in Figure 7 (with the exception of map production and presentation) were presented in the online survey and the respondents were asked which use tasks they think were respectively executed by persons that professionally consult a land use plan map or structure plan map and by citizens. In Figure 7 the numbers indicate which percentage of the respondents mentioned a particular use task. The listing of use tasks in Figure 7 seems to be quite complete, because the respondents mentioned no or hardly any other use tasks. When they were asked directly whether during consultation structure plans at provincial level are compared with municipal structure plans, about one in four respondents replied that that is happening often and 40% replied 'occasionally'. One third of the respondents did not know and only two respondents replied that such a comparison never takes place. With this we think that the value of reality of use case scenario 1 has been proven.

	Users																
	Professionals													*Consumers*			
	Civil servant (national)	Civil servant province	Civil servant KWG	Civil serv. municipality	Civil servant water board	Lawyer / legal advisor	Consultancy firm	Architect	Project developer	Real estate agent	Advisor public utility	**On-line survey (%)**	Citizen	Business man	Interest group / lobby	**On-line survey (%)**
Use tasks																
Map display structure plan																
Map production for plan design / development of urban and regional planning scenarios	*	*	*	*	*		*					-				-
Localizing existing geographic objects	*	*	*	*	*	*	*	*	*	*	*	14	*	*	*	11
Comparison with current use of space	*	*	*	*	*	*	*	*	*	*	*	46	*	*	*	32
Comparison with visions at other policy levels (e.g. for checking plans and finding locations for urban & regional development)		*	*	*	*		*					72			*	33
Presentation (for public participation and deliberation)	*	*	*	*								-				-
Obtain insight into future spatial changes of the environment									*	*		80	*	*	*	90
Land use plan (map)																
Map production (representation object designations)		*	*	*			*					-				-
Localizing existing geographic objects	*	*	*	*	*	*	*	*	*	*	*	42	*	*	*	29
Comparison with current use of space	*	*	*	*	*	*	*	*	*	*	*	49	*	*	*	37
Harmonization with structure plan		*	*	*			*					40				7
Checking plans (e.g. through comparison with submitted building schemes)		*	*	*								82				47
Maintenance (e.g. through comparing the plan map with a recent aerial photograph)		*	*	*								68				13
Monitoring (through map comparison and fieldwork)	*	*	*	*	*							29			*	1
Determination of (legal) possibilities and limitations on a specific land parcel (what is allowed here? / what is allowed where?)						*	*	*		*	*	82	*	*	*	79
Localizing possibilities / limitations for particular designations in the land use plan area (if I want this, e.g. building a house, where is this allowed in this plan area?) (where is what allowed?)							*		*	*	*	73	*	*		61
Obtain insight into the spatial distribution of a specific designation									*	*		35	*		*	11
Obtain overview of all designations in a land use plan area									*	*	*	68	*		*	40

Figure 7. Users of physical planning maps and their tasks

8. FUTURE GENERALIZATION DESIRES

The value of reality of use case scenario 2 was confirmed as well: somewhat more than 50% of the respondents clearly indicated that for consultation (at the same scale of representation) the topographic base map of a structure plan should be different from the topographic base of a land use plan map. Only less than one third of the respondents said that the topographic base map may be the same and the rest did not know. Even more clear is that more than 80% of the respondents agreed whole-heartedly with the proposition: 'For consultation at the same scale of representation the topographic base map of a land use plan should be more detailed and more accurate than that of a structure plan.'

The different generalization desires for the topographic base map find expression very well in the order of importance – as indicated by the respondents - for the incorporation of elements of the topographic base for the consultation of land use and structure plan maps (Tables 1, 2 and 3).

1	Individual buildings
2	Building plots
3	Cadastral boundaries
4	Roads
5	Railways, water
6	Municipal boundaries
7	Land use plots (e.g. woods, sports grounds)
8	Civil engineering objects (e.g. bridges)
9	Furnishing elements (e.g. poles, pylons, street furniture, enclosures)

Table 1. Order of importance of topographic base map elements for the consultation of a land use plan map at scale 1 : 25,000.

1	Main roads
2	Land use plots (e.g. woods, sports grounds)
3	Water
4	Municipal boundaries
5	Building plots
6	Railways
7	Secondary roads
8	Individual buildings
9	Cadastral boundaries
10	Civil engineering objects
11	Furnishing elements

Table 2. Order of importance of topographic base map elements for the consultation of a structure plan map at scale 1:25,000.

1	Main roads
2	Land use plots (e.g. woods, sports grounds)
3	Railways
4	Water
5	Municipal boundaries
6	Building plots
7	Secondary roads
8	Civil engineering objects
9	Individual buildings
10	Cadastral boundaries
11	Furnishing elements

Table 3. Order of importance of topographic base map elements for the consultation of a structure plan map at scale 1 : 75,000.

The order of importance of topographic base map elements for the consultation of structure plan maps is clearly different from the order of importance for the consultation of land use plan maps (compare Table 1 with Table 2). For structure plan maps at different scales (compare Table 2 with Table 3) the differences in order of importance are not that big. However, at smaller scale maps more will have to be left out and graphic simplification is also required with the generalization.

More than 90% of the respondents are of the opinion that the mutual fitting of the topographic base map of land use plan maps and the plan information layer is important or very important. The figure for structure plan maps is almost 65%. This result is also very relevant for the generalization because, therefore, the location and representation of, for instance, the boundaries of the land use areas must be taken into account very consciously during the cartographic generalization of the topographic base map. In other words: during the cartographic generalization of the primary information layer, the topographic base map should be generalized in conjunction.

To conclude, we do not want to withhold from you that more than 70% of the respondents agreed with the proposition: 'There will have to be national and legally binding agreements about the use of topographic base maps in the production and consultation of land use plans and structure plans' (only 20% disagreement). In addition, 82% agreed with the proposition: 'With a digital physical planning map (land use plan or structure plan) it should be stated on the basis of which topographic base from which year that planning map has been produced.'

9. CONCLUSIONS

In our user research project we also requested the participants to react to the proposition: 'For the consultation of a land use plan a base map is not at all required anymore if the land use designations are digitally recorded as geographic objects.' Only 10% of the respondents agreed with this proposition. Indeed, it is beyond doubt that, also in a digital environment, topographic

base maps are still very much required when transferring plan information. This is confirmed by the results of the user research project that has been described in this paper. Topographic base maps may function better when they are not based on existing map materials that have been produced for other purposes. Through a proper generalization and a suitable map design they can be better adjusted to the purpose and scale of the physical planning maps. Some concrete results of the executed user research may already be employed in the formulation of rules for driving a possible automatic generalization process. In this respect, you may think of the selection of elements of the topographic base for land use and structure plan maps at different scales and of the mutual harmonization with the cartographic elements of the plan information layer ('generalization in conjunction'). In doing so, there should no longer be a sudden transfer from one existing topographic base map product (including aerial photographs) to another, but there may be a generalization from one and the same geographic database. The mutual comparability that will be fostered by this is also required in a national web portal for physical plans and should be based on standard rules for generalization and design. The thing is now to come to a first technical implementation and the results of that, as such required to demonstrate that it may also be done differently than with the help of existing map materials, will again have to be subject to user research. Citizens should also be involved in that future user research, and the use tasks will have to be formulated in an even more concrete way in order to perfect an automatic generalization based on rules of use.

10. REFERENCES

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10.2 URL

URL1: RO-online http://www.ruimtelijkeplannen.nl/ (accessed 10 Sep. 2010)

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