

# **Visualizing scale related uncertainty in web maps for spatial planning**

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GIMA Msc. Thesis  
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## **Abstract**

This research deals with the effects of digitizing spatial plans. Spatial plans are considered as spatial policy expressed as maps and text. Focusing on the maps, the research shows that uncertainty is part of the nature of spatial plans. Much of this uncertainty is related to scale. Its impact increases in a digital setting.

The research presents alternative designs for three maps taken from a case. They are implemented in a web viewer, based on OGC specifications. The visualization changes according to the scale at which it is viewed. In a survey the concepts of visualizing uncertainty, the maps and the suitability of OGC specifications are evaluated. The results show that respondents believe that uncertainty can and should be visualized in digital spatial plans.

## **Samenvatting**

Dit onderzoek gaat over de effecten van de digitalisering van ruimtelijke plannen. Ruimtelijke plannen worden beschouwd als ruimtelijk beleid uitgedrukt in de vorm van kaarten en teksten. Het onderzoek richt zich op de kaarten. Het toont aan dat onzekerheid bij de interpretatie van ruimtelijke plannen een belangrijke rol speelt. Deze onzekerheid is vaak gerelateerd aan schaal. De impact ervan neemt toe in een digitale omgeving.

Het onderzoek heeft geleid tot alternatieve ontwerpen voor drie kaarten uit de praktijk. De oorspronkelijke kaarten zijn afkomstig uit Agenda voor een Vitaal Platteland, Meerjarenprogramma 2001 – 2013 (MJP2). De kaartontwerpen zijn in een kaartviewer geplaatst, gebaseerd op OGC specificaties. De visualisatie verandert al naar gelang de schaal waarop de kaart wordt bekeken. In een enquête zijn verschillende aspecten van de kaarten beoordeeld: het visualiseren van onzekerheid an sich, de feitelijke kaarten en de bruikbaarheid van OGC specificaties. Uit de resultaten blijkt dat het volgens geënquêteerden mogelijk en wenselijk is om onzekerheid in digitale ruimtelijke plannen te visualiseren.



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I started the programme in September, 2005. GIMA was set up as programme suited for people with jobs. My employer, the municipality of Oldebroek supported me in my choice to embark on what turned out to be five years of adventure. The support and endurance shown by the people at Oldebroek and - most of all - my family have meant a lot to me these past years.

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The research went public in May 2010, when the survey was put online. I thank all respondents and also Marian de Vries for allowing me to use the server at OTB Delft and taking care of the installation.

Steven Keijzer

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# **1 Introduction**

## **1.1 Motivation and problem statement**

In the Netherlands, spatial plans are published by various bodies of the government. Spatial plans are a specific type of policy documents that refer to areas or locations within the jurisdiction of the government. The plans generally consist of a combination of text and maps. They are used to support all kinds of decision making by citizens, organizations and governmental bodies.

National policy is often interpreted locally. This is true especially for spatial plans. While spatial plans used to be published in print, the Dutch National government now aims to offer their services and policy documents online as much as possible.

With the rise of digital availability of maps, especially via the World Wide Web, the way spatial plans are disseminated and interpreted are changing. New methods of geographic visualization have come up. At the same time users attitudes towards maps have changed as they are allowed more control over the information and how it is presented (Slocum et al., 2009).

The interpretation of a spatial plans is never easy. Users must be aware of levels of uncertainty that is present in the plan. Only then they are able to assess the effect of a plan on their situation. In the changing digital context, the process of interpretation is changing as well. It is likely that uncertainty will present a more serious problem than before to the governments that define spatial plans. Often, uncertainty in digital spatial plans is in some way related to scale. For example, users are free to zoom to any location, whereas printed maps are static in that sense.

This research is a master thesis project. It addresses the topic of uncertainty in digital spatial plans. Uncertainty in geo information is much discussed and numerous definitions are used. All are in some way related to the concept of geo information being a model of reality. When dealing with spatial plans it is important to keep in mind that spatial plans are essentially designs and not models of reality as such.

Uncertainty provides a challenge for the cartographic representation. Theory on the visualization of uncertainty offers methods that can be applied to uncertainty in spatial

plans (MacEachren et al., 2005). Visualizing uncertainty may involve advanced graphic variables, that are not always supported in GIS applications. It is to be expected that this is also true when they are applied in web maps.

The relation between maps and other information is relevant. Textual information may offer solutions where cartographic solutions are not sufficient to support the right interpretation. Spatial plans always combine maps with textual information that goes beyond a simple map key or legend.

The publisher aims at a desired interpretation of information by the user. Therefore dealing with uncertainty and its potential effects on interpretation is an important concern.

Central issue to the research is how the visualization of scale related uncertainty can be used for the publication of spatial plans via the Web, according to the standards and specifications of the Open Geospatial Consortium (OGC). This is an important notion for governments. Compliancy to OGC standards and specifications is considered to be a condition for interoperability among publishers and users of geo-information (OGC, 2005). The research includes the design of a visualization according to those specifications. The suitability of the specifications for this application is evaluated.

To test the design results and other findings from the research, a survey was held among planning professionals.

## **1.2 The case**

The Dutch ministry of Agriculture, Nature and Food quality has published a policy document for the countryside, "Agenda voor een Vitaal Platteland, Meerjarenprogramma 2007 – 2013", abbreviated as MJP2 (LNV, 2006). MJP2 will serve as a case for the research. It contains a number of maps from national spatial plans. The maps represent the current Dutch spatial planning practice. Together they provide solid input for a case study. Interestingly, for these maps the ministry was hesitant to publish the maps in digital form because they were not sure if they would be interpreted correctly. This shows that uncertainty is a relevant issue. It also shows the potential of the case for the research.

Datasets of the maps were kindly made available by the ministry. They were used for research into suitable types of visualization and the design of a web based visualization.

Earlier, the case data was used in the Geo3 research group (Vullings et al., 2009).

### **1.3 Research objectives and research questions**

There are two research objectives:

- A Design of a visualization of scale related uncertainty in spatial plans.
- B Implementation of the visualization in a web based map viewer.

The research questions follow from the objectives. They are:

- A1. How can scale related uncertainty in spatial plans be defined and/or classified?
- A2. Which are the demands that uncertainty places on the visualization, both from the publishers and users perspective?
- A3. Which types of visualization are suitable for scale related uncertainty?
- B1. How can the visualization be implemented in an OGC compliant portrayal service?
- B2. Which factors influence the interpretation of uncertainty in spatial plans that are published on the web?

### **1.4 Research methods**

The research is set up in three phases, as shown in figure 1. First phase is a literature study, focusing on uncertainty, for three fields of study. They are Spatial planning, the cartographic visualization of uncertainty and (OGC compliant) web mapping. It will result in a framework or methodological approach for the other phases. The second phase is the phase of design. It will start with an analysis of the case material, which will be subject to design. When the actual design is completed, the design results are input for the final phase, the evaluation. An evaluation of the results is performed through a survey among planning professionals.

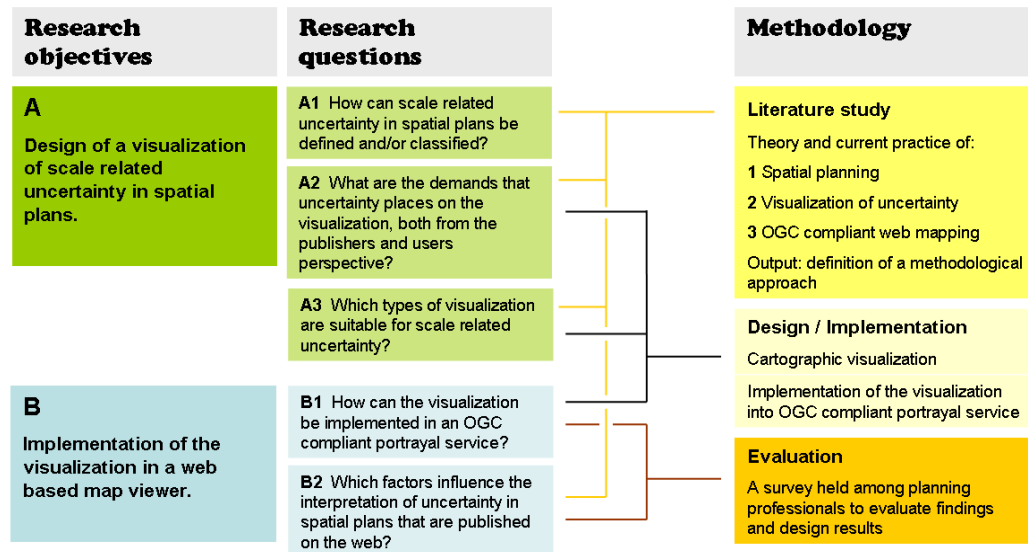


figure 1 Overview of the research set up

## 1.5 Outline of the thesis

Chapter 2 presents the findings from literature study in the three relevant fields of study. They are spatial planning in the Netherlands, cartographic visualization of uncertainty and web mapping. A framework is presented that will be used in the other chapters.

Chapter 3 introduces the case, while applying the findings from literature and practice. The problems concerning the visualization of uncertainty in the case are identified and analyzed. This provides the input for the visualization design which is described in chapter 4. The visualization design is made irrespective of any specific application for Web mapping. It proposes an optimized visualization as a solution to the problems identified in the case. Factors other than the actual thematic visualization are described and suggested for further research. The design is then implemented in a Web map viewer. Chapter 5 presents the evaluation results. Conclusions and recommendations are presented in chapter 6.

A glossary is included to explain specific terms used in Dutch spatial planning, as well as some abbreviations and other definitions.

## **2 Backgrounds**

### **2.1 Spatial planning**

Spatial planning arranges and organizes the use of space according to the demands and values of the era. It deals with the development of new cities, roads and railways, the protection of nature areas, development of the countryside and many other spatial processes (Van der Cammen and De Klerk, 2003). In other words, it contributes to the spatial order of our time (Van der Woud, 1987).

#### **2.1.1 Spatial planning in the Netherlands**

By law, the government is responsible for the coordination of spatial planning. The government develops spatial plans to do so. Spatial plans are laid down by decree of the various bodies of the government, operating at the local, provincial and national levels. In Europe, spatial plans are made and discussed at a transnational level as well, although the European Community has no legal competence in spatial planning (Dühr, 2007).

The main responsibility for spatial planning in the Netherlands lies with the Ministry for Housing, Spatial Planning and the Environment (VROM). The Ministry sets out the main principles and guidelines for national spatial planning policy.

For many years, spatial planning in the Netherlands has essentially been a regulatory phenomenon, based on a strong government imposing its conception of space on society (Mommaas and Janssen, 2008).

The most important detailed plans are the local zoning plans (bestemmingsplannen). They may forbid or allow a type of land use for specific locations. Therefore they have a strong legal impact for individuals.

In recent years this regulatory practice has been much debated. It is considered less and less effective in a dynamic society where balancing spatial claims has become very complex (Mommaas and Janssen, 2008). In 1998, the Dutch Scientific Council for Governmental Policy (WRR) proposed a more developmental approach to spatial planning instead of the regulatory practice. It should be based on communication and conviction rather than on principles of command and control (WRR, 1998). WRR identified a need for differentiated instead of generic spatial concepts and for a more

selective, strategic involvement of national government in spatial issues, leaving room for regional initiatives. Private parties should also become more involved in the spatial planning process, as they are partners in the realization of spatial developments.

This developmental approach to spatial planning has been largely adopted by the national government. In the current national spatial planning policy document “Nota Ruimte” and the new spatial planning act (VROM, 2004; 2008), a new interpretation of the subsidiarity principle is used as a motto: Decentralize whenever possible, centralize only if necessary.

As the practice of spatial planning has become more dynamic, the roles of the various governmental bodies have become more diverse. The roles of spatial plans are also evolving. They should motivate and facilitate, instead of only regulate, private (and public) activities (Mommaas and Janssen, 2008).

### 2.1.2 Purpose and nature of spatial plans

In this dynamic context spatial plans are made and published. Spatial plans carry a policy, which is the content of the plan. The policy is a spatial policy, meaning it is always connected to locations. In a sense it is just another type of policy that is conceived and published by governments. Organizations and individuals can comment on a plan or object to it in a procedure of appeal. Any spatial plan is a result of long deliberations and research. In its final form it should enable the execution of a policy and / or enable other authorities to develop a more detailed policy. A spatial plan should therefore express the content of the policy and support the interpretation by organizations and individuals (VROM, 2008).

Spatial plans may be specific or vague. An example of a specific plan is a local zoning plan, which may specify the exact location where a school can be built. Examples of less specific or vague plans are strategic plans, for example a plan to support agricultural developments in a large area, without specifying exact locations.

Considering the various types of plans, it is helpful to identify a number of separate continua. Combined, they could typify the kinds of spatial plans that are currently used in the Netherlands, as shown below:







Continua	
 <b>jurisdiction</b> 	<p>Governments responsible for a plan may be local, provincial or national. This defines their <b>jurisdiction</b>. However, the roles of governmental bodies are less static than before. It depends on the theme as well as the scale who is in charge of what.</p>
 <b>scale</b> 	<p>The policy of a plan is valid at a certain <b>scale</b>, e.g. locally or nationally. This does not always fully correspond to the jurisdiction of the governmental body responsible for the plan. For example, provinces may in some cases make spatial plans at local scale.</p>
 <b>impact</b> 	<p>By nature, the legal <b>impact</b> of a spatial plan may be weak or strong. For example, a strategic plan may not have a direct impact on an individual. However, it may create conditions for more detailed plans that will be based on it.</p>

table 1 The three continua that typify spatial plans in the Netherlands

These three continua cover a number of basic aspects of the nature of spatial plans. One could argue that in order to be able to interpret a spatial plan correctly, one should know about the positions on these continua.

Arguably, a fourth continuum could be the status of a plan in terms of its plan procedure. The status mainly depends on the current stage of the procedure of political decision-making which ultimately result in spatial plans with a fully valid legal status. In the procedure, it is published for citizens and organizations to react or object to it. From the perspective of uncertainty, the status of a plan does not touch upon the actual nature of the plan. It is outside the actual content. The spatial plan as it is first published, should have the same content (policy) as it is intended to be in its final form. This is why status is not listed here.

The policy of a plan is 'invisible' until it is expressed through a vocabulary or language. This expression consists of the textual content of a plan, as well as maps. The language of spatial plans is quite diverse, both for the textual content of the plans and maps.

The text may comprise labels of features on a map, text referring to specific features and other, external textual content, not directly related to the map.

In the text, all sorts of concepts are used, expressed by terms. These terms refer to the many aspects of policy, including its impact and certainty. Terms may be very specific or not.

The same diversity can be found in the vocabulary of maps. It would be interesting to see how maps and text (or concepts) correspond. This will be analyzed in chapter 3, using examples from the case.

Differences in describing and presenting the content of spatial plans can be explained in part by the different purposes of spatial plans in the current practice of planning in the Netherlands. However there may be cultural aspects as well. Dühr (2007) found that cultural differences among European nations are an obstacle for cooperative international planning. These differences are manifest in the language of spatial plans.

The same is true within the Netherlands, where spatial plans are made by different governmental bodies and planning offices, spread across the country and dealing with different themes.

The diversity in spatial plans is caused in part by the position of plans on the three continua. Also there is a richness or inconsistency in the vocabulary that is used to express the content of plans. These differences can make it hard to interpret and compare spatial plans. In other words, they may cause uncertainty.

Differences in the vocabulary or language of spatial plans have been an important issue in the DURP standardization program, which will be discussed in the next section.

It is now possible to identify three dimensions of spatial plans, as shown in figure 2. Spatial plans can be considered as entities that have three dimensions: the policy, its expression and the underlying continua. All of these are in some way important when the uncertainty in a spatial plan is observed.

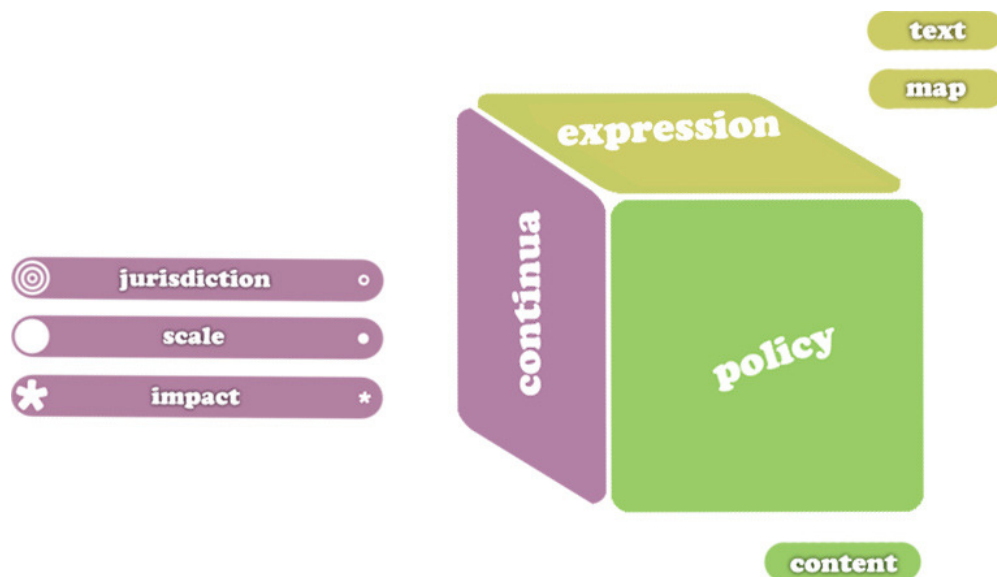


figure 2 The three dimensions of a spatial plan: continua, policy and its expression



### 2.1.3 Digital spatial plans in the Netherlands

Over the past years, digital maps and datasets have started to replace paper maps as the medium for spatial plans. This is still in progress. In the Netherlands, the DURP program was initiated by the government to deal with the shift towards digital spatial plans. DURP stands for *Digitaal Uitwisselbare Ruimtelijke Plannen* (Digitally Exchangeable Spatial Plans). To be able to exchange spatial plans, they should first be made comparable. Therefore a set of standards was developed, defining the vocabulary for maps and terms, as well as technical specifications. These Standards for Spatial Planning (RO Standaarden) are now legally binding (Geonovum, 2008).

Through DURP, the government aims at a higher level of efficiency and effectiveness in the process of using and sharing spatial plans. Why would governments have to send large sets of printed documents around, if they can be shared via the Internet? And why should citizens that are moving from one town to another have to face two zoning plans offering similar information in formats that are entirely different? The concept of e-Government (UN, 2009) mainly addresses the issue of accessibility. It aims to offer better services to citizens, preferably online. In the Netherlands, a program called *Andere Overheid*, or “A Different Government” was set up for this purpose. DURP is considered part of this broader program.

Another important national innovation program was called RGI (Ruimte voor Geo-Informatie; Space for Geo-Information). RGI supported projects including DURP through research and knowledge exchange. RGI was intended to contribute to a national Geo-Information Infrastructure or GII (Besemer, 2005; De Graaf, 2006). The goal of a GII is to create the conditions for public organizations and others to share geo information efficiently.

The process of defining the DURP standards and reaching agreement upon them, has roughly taken seven years. This long period is largely due to the difficulty that was found in reaching agreement on language issues as discussed above. Planners considered standardization as a threat to their creativity and autonomy (De Graaf, 2006).

Prior to standardization, features that were similar in their purpose and intentions were described and displayed according to the preferences of different governments and planning offices. As mentioned before, part of the explanation for these differences could be found in different cultures and practices in dealing with national spatial planning law.

For visualization, so far the standards only cover the forementioned zoning plans. Local zoning plans are made by municipalities. Typically, they contain large scale data and objects that have crisp boundaries. Boundaries are based on property boundaries, large scale topographic maps or detailed aerial images. The standards demand that plans be object oriented. Maps should be made as GML files containing links to regulations specified in HTML format (Geonovum, 2008). This shows how the data model and visualization of a plan are related.

Considering these characteristics, it could be argued that local zoning plans are the easiest spatial plans to develop standards for. The fundamental concept of how they are made as thematic maps was never really disputed in the debate about the development of standards. The debate focused more on the terminology, categories and visualization which are allowed as expression of the spatial plan.

In theory, using the standards, the conception of content i.e. the policy is free as it was before. Still, the standards influence the content of zoning plans indirectly. As said, the expression of the content is standardized. As a result, the vocabulary is limited as only a certain set of symbols and terms is available. For example, there are cases where types of land use do not properly fit in any of the standard categories. A pharmacists', for instance, offers a mixture of commercial and medical services. It's a challenge to place it in one specific category.

One can think of many future developments following the implementation of digital spatial plans. For instance one could search for types of locations through queries. Also it could be possible to do some automated analysis and processing of spatial plans (VROM et al., 2009). Overlay operations of different spatial plans could be used to trace areas with conflicting attributes. This may seem like a logical next step. However such operations on spatial plans would require that the uncertainties related to the plans information is fully clear.

Judging by the efforts and results of defining standards for zoning plans, it is not easy to standardize spatial plans other than zoning plans. Potentially, standards can help to clarify the status of plans on the three continua by introducing a universal vocabulary. This can make it easier to compare plans and may reduce the effects that cause uncertainty. The DURP project has shown that standards are a condition if users want to be able to compare plans.

A number of issues surrounding digital of spatial plans was addressed in this section. They are likely to have certain effects from the perspective of the continua that were introduced in the previous section, or rather, on how the continua are perceived and interpreted. An overview of these effects is given in table 2.







Effects of digitizing	
 <b>jurisdiction</b> 	<p>It is easier to view, overlay and compare spatial planning maps from different governmental bodies. As a result it may become less obvious who is responsible for which policy and how the plans relate.</p>
 <b>scale</b> 	<p>In digital applications maps can be viewed at any scale. The scale at which they are viewed can be different from the scale at which they are conceived and intended to be valid.</p>
 <b>impact</b> 	<p>Visual variables that are used in paper maps to display different levels of impact, may not correspond or may not be available in similar form in a digital setting. This may cause confusion.</p>

table 2 Potential effects of digitizing spatial plans from the perspective of the continua

Essentially, the publisher has less control over the interpretation. People can view and combine plans at different scales. They may choose to view only small segments of a map without looking at the whole. In general, these effects may cause the uncertainty that is inherent to spatial plans to increase in digital environments.

#### 2.1.4 Uncertainty in spatial plans

So far in this research, uncertainty has been used as a term describing problems that may occur in the interpretation of spatial plans, related to the continua and vocabulary. Clearly uncertainty affects the interpretation of digital spatial plans and the decisions that are based on the interpretation. Information about the nature and degree of uncertainty may therefore be helpful to make the right decisions.

In order to deal with uncertainty, a definition of uncertainty is needed. A first step would be to take a look at definitions of uncertainty available in geo-information science. Doing this, it is important to see what sets spatial plans apart from other geo-information.

In GI literature, there is no universally recognized definition for uncertainty (Pang, 2001). Uncertainty is mostly equated, to some extent, to imperfection, unreliability or poor quality of values of an attribute on a spatial location (Duckham et al., 2001; Slocum et al., 2009). It is sometimes addressed as a sub domain of data quality (Thomson et al., 2005; Drecki, 2007).

These definitions refer in some way to the concept that maps are strictly models of reality. Maps are used to visualize geospatial data, referring to actual locations or attributes of objects or phenomena on earth (Kraak and Ormeling, 2003). From this perspective, the difference between a model and reality is considered as a problem and uncertainty as one of its facets.

In spatial plans there is an intentional difference between model and reality, because they describe a *possible* future state or development for locations. They express a policy rather than an actual situation bound to locations. They are, to some extent, designs. The use of terms like unreliability or imperfection is often not appropriate because of their negative connotations. Uncertainty may be present in spatial plans by intention. For example a map may show a number of possible locations for a new road. It is uncertain where the road will be built. Still, as described in the previous sections, uncertainty in spatial plans presents a real problem as it is vital for the interpretation.

Uncertainty can be present in spatial plans, or rather in its expression, consisting of text as well as maps. An example is how textual content is related to locations. It could refer to locations using phrases like “in the proximity of natural parks” or “large towns” or similar. Similarly, any feature on a map, e.g. a red circle, refers to a textual description which could be anything from a simple map key or legend, up to a full set of legal regulations (Boer et al., 2007). The relation between text and maps may therefore cause ambiguities and uncertainty, especially when spatial plans are compared.

Vullings et al. (2007) found that comparing and analyzing spatial plans in the Netherlands can be problematic due to differences in scope, intention, scale and other aspects of data quality and uncertainty like semantic ambiguity and unknown lineage. Of these, differences in scope, intention and scale can be seen as variations on the continua that were introduced above. Semantic ambiguity may occur in the vocabulary, the expression of a plan, like in the examples in the preceding paragraph. What remains are issues like unknown lineage, which can be classified as types of error.

As said, the visualization is part of how the plans content is expressed. Specifically for the visualization, uncertainty may originate from the process of creating the visualization. This can be perceived as the “Visualization Pipeline” (Pang et al., 1997; Leyk et al., 2005). Data is first collected, information is derived from it and finally it is visualized (figure 3). All of these steps may contribute to uncertainty.

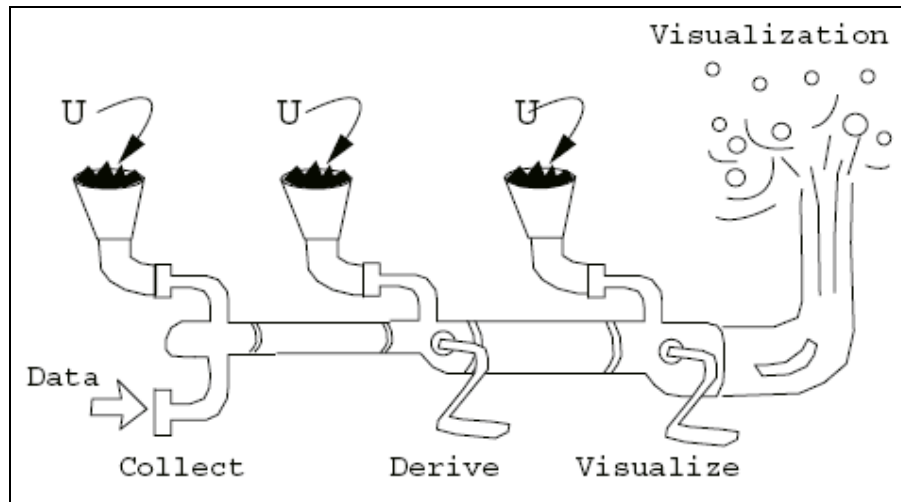


figure 3 The Visualization Pipeline (Pang et al., 1997).

For spatial plans, which are expressed in both text and maps, one might think of an “Expression Pipeline”. The process of digitizing spatial plans, that was discussed in paragraph 2.1.3, can be seen as a segment of the pipeline. In digital spatial plans the impact of uncertainty may become larger, specifically for scale related aspects. Similar origins may exist for other, textual parts of spatial plans. As this research focuses on visualization, they are not expanded upon here.

Vullings et al. (2007) proposed a definition for uncertainty, that allows for the variety of its characteristics and origins:

*Uncertainty is the acknowledgement that one does not exactly know the situation of a system because of imperfect or incomplete information.*

One reason why this definition is appropriate in the context of spatial planning is that it is neutral in the sense that uncertainty is not labeled solely as a problem. Second, it provides a base to approach the various types of uncertainty that can occur in spatial plans.

Based on the definition, Vullings et al. (2007) have proposed a taxonomy, classifying the nature and sources of uncertainty in spatial plans, as well as possible solutions or ways to handle it. In the taxonomy, uncertainty may originate from sequential steps in the process of making spatial plans.

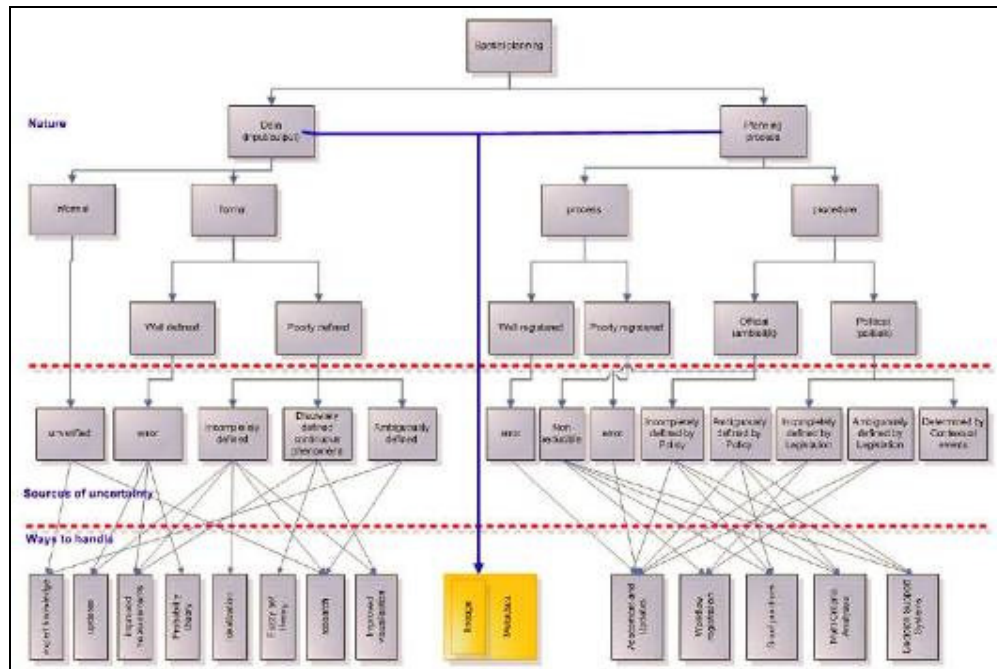


figure 4 Taxonomy of uncertainty in spatial planning, (from Vullings et al., 2007)

The process is split up in two parts: the actual conception of the spatial plan and the planning process. In the planning process, the right half of the taxonomy, political and procedural processes cause different types of uncertainty. A typical solution proposed by the taxonomy in this section is to implement workflow registration, so the effects of sequential decisions can be traced.

The left half of the taxonomy is the most relevant for this research as it deals with the actual conception of spatial plans. In a sense it represents the "Expression Pipeline". It tells that the nature of uncertainty in a spatial plan may be described as "poorly defined", referring to the data concerning policy or locations. Other, more obvious sources of uncertainty are error and lack of verification. Solutions for such problems include research and expert knowledge. As this research deals with maps, the question is: what does it mean when objects in the map are poorly defined?

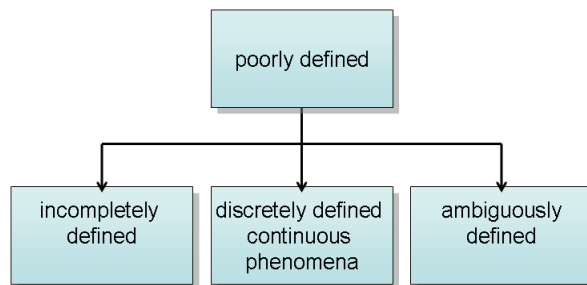


figure 5 Excerpt from figure 4 Taxonomy of uncertainty in spatial planning, (from Vullings et al., 2007)

The taxonomy lists three possible causes for objects to be poorly defined (figure 5). Below, they are shortly discussed and put in context using examples.

- Objects may be incompletely defined. It could be argued that in spatial planning maps objects are sometimes incompletely defined by intent. Sometimes the status or concreteness of a plan may be the cause for this.
- Second, objects may be discretely defined while they represent continuous phenomena. An example would be the risk area around a chemical plant. Obviously, the risk will decline gradually as the distance to the plant increases. However, such areas are mostly defined discretely, e.g. a 50 meter buffer zone in which the construction of houses is not allowed.
- Finally, objects may be ambiguously defined when the meaning or location is not clearly expressed. This may be the case when an object in the map and the concept that it represents, do not match or even contradict each other.

Improved visualization is one of the main solutions that are proposed for these types of uncertainty. Application of fuzzy set theory is another one, that can also be translated into a visualization. Visualization is not mentioned as a solution for ambiguously defined objects. This type of uncertainty can not be 'fixed' using visualization because it involves a contradiction in the plans content. So, instead research or expert knowledge is recommended.

Clearly, these solutions may impact the conception and appearance of the actual plan. They could pose demands on the vocabulary of a plans expression, specifically the visualization.

Additionally, the taxonomy suggests the use of good metadata, including lineage, as a general rule to deal with uncertainty from all sources. Various aspects of the information can be traced and its certainty can be evaluated. Arguably, the information about the continua discussed earlier, could best be included here. This is information that is not part of the actual expression of the content, but vital for the interpretation.

## **2.2 The visualization of uncertainty in spatial plans**

As section 2.1 has shown, maps are an important vehicle of the content of spatial plans, perhaps more so in a digital environment than before. In the taxonomy, Vullings et al. (2007) have argued that improved visualization can be a solution for dealing with uncertainty. This section will introduce the available tools for the visualization of uncertainty.

### 2.2.1 Visualization of scale related uncertainty in spatial plans

MacEachren et al. (2005) have noted that the visualization of uncertainty is still a challenge for the GI community. Nonetheless, a number of methods have been proposed since the problem was identified. These solutions can be categorized as follows.

In general, uncertainty is perceived as an extra variable related to the thematic information of the map. It can be an attribute of this information. The uncertainty can be depicted using intrinsic or extrinsic visual variables (Slocum et al., 2009). Intrinsic representation involves variations in the visual variables applied to the thematic objects themselves. This results in bivariate maps, because the thematic information and the information about uncertainty are shown in one map.

Extrinsic representation involves the use of separate visual tools for the uncertainty, separate from the thematic objects. Instead of using a single map, two maps may be made that are shown side by side or as stacked layers. It is very unlikely that extrinsic representations can be used effectively in spatial plans. They are predominantly used in scientific applications, while spatial plans are supposed to be accessible and understandable for citizens or non experts. Also, this type of visualization would be a major departure from the maps that planners traditionally use. MacEachren et al. (2005) found that for decision making, there are risks involved when adding uncertainty information to maps. Expert users may be able to incorporate the added information into their decisions. When a map or a set of maps becomes complex, lay map users will most likely revert to heuristics rather than make a full analysis of all aspects of the information. Again, this is a motivation to choose against extrinsic representations for spatial plans. It is also a strong appeal to be careful when adding the certainty information in bivariate maps. The added information may obscure the message of maps. Clearly, it only makes sense to add information if it leads to better decisions.

Theoretically, since the days of DURP, in Dutch spatial planning there are some basic conditions that could help implement the use of bivariate maps displaying certainty information. In DURP an approach was chosen to make spatial planning maps object oriented (Geonovum, 2008). This means that all (attribute) information is attached to thematic objects. This connects very well to the concept of bivariate maps using intrinsic visual variables. In theory, if the attribute information of thematic objects includes a statement about its (un)certainly, this can be translated into the visualization of each individual object on the map.

It would be interesting to find out which visual tools are available to display uncertainty in bivariate maps.



## 2.2.2 Intrinsic visual variables

differences in:	symbols		
	point	line	area
size			
value			
grain/texture			
colour			
orientation			
shape			

figure 6 Visual variables of Bertin (1967).

A valid starting point for an inventory of visual tools for map design is the set of visual variables developed by Bertin (1967). This set contains some variables like shape that are effectively used in spatial plans to depict levels of certainty. For instance a dashed line is a commonly accepted visual tool to depict a preliminary status of a border or line object. To assess the suitability of variables, it is vital to understand the phenomenon that they should convey. Uncertainty is considered as a component of the information that will be visualized in maps. All components of information in a map can be considered from the perspective of measurement scales (Kraak and Ormeling, 2003). Possible measurement scales are nominal, ordinal, interval or ratio scales. In theory, uncertainty, as it was defined above, can be expressed statistically. However in the context of planning it is very unlikely that very precise figures will apply. Most often, it is expressed in terms of likelihood rather than precise figures e.g. percentages. This means that uncertainty in the context of spatial planning is best perceived as an *ordinal* measurement scale. In situations where specific statistical information is available, it could be considered as a ratio measurement scale.

Kraak and Ormeling (2003) show which of Bertins variables are suitable for each measurement scale. For ordinal phenomena, grain/texture stands out. Value and size may be used as well. Size is the most appropriate variable for the ratio scale. Colour, orientation and shape are suitable only for phenomena that have a nominal measurement

scale. Arguably, in spatial plans much of the thematic information, not being uncertainty, can be considered as such. Potentially, this could allow different components of the information alongside each other.

After Bertin defined his set of variables, many extensions to that set have been suggested. A number of these have been proposed specifically to display levels of certainty. MacEachren (1995) does so, taking into account the possibilities of digital display of maps which had since emerged. MacEachren proposes saturation and clarity, the latter of which is subdivided into separate visual variables. Not surprisingly, they connect to the grain/texture and value variables offered by Bertin and they are considered suitable for an ordinal measurement scale. Their main characteristics are listed in table 3.

Variable		description
Saturation		Pure hues for certain information, less saturated hues for uncertain information.
Clarity	Crispness	Crispness or fuzziness of areas and boundaries (including lines).
	Resolution	Level of detail, for polygons, lines and points
	Transparency (or fog)	Fog is placed over the thematic data. More foggy means less certain. Suitable for polygons, lines and points

table 3 Extensions to Bertin's visual variables considered suitable for portrayal of uncertainty. Adapted from (MacEachren, 1995)

It is noteworthy that the three sorts of clarity represent quite different solutions. Saturation has since been evaluated as less effective for uncertainty visualization compared to other variables. Additionally it has been proposed that transparency (or opacity) can be applied to the actual thematic objects as well (MacEachren et al., 2005). Jiang (1998) showed that crispness (fuzzy borders) can be applied to colour as well as opacity (as proposed by MacEachren (1995)).

An interesting point in bivariate maps is how variables interact when they are combined. For instance, using transparency combined with different colors may impact the effectiveness of these tools. Some colors may dominate the map in spite of their transparency. The same may be true for saturation combined with different colors.

Finally, various more advanced techniques have been proposed for the visualization of uncertainty in bivariate maps. Examples are glyphs and dynamic representations e.g. animation and blinking (Fisher et al., 2002; MacEachren et al., 2005). These techniques may be powerful but are mostly used in a scientific setting. They can actually get in the way of the data themselves and are therefore not likely to be suitable in the context of spatial planning.

To create an overview, the variables that were discussed can be categorized as shown in table 4. The ones that are theoretically most suitable for spatial plans are highlighted.

Standard	Extended	Advanced
Bertins set:	Saturation	Glyphs
Size	Clarity - Crispness	Animation - Blinking
Value	- Resolution	- ...
Grain/texture	- Transparency	
Colour		
Orientation		
Shape		

table 4 Three categories of visual variables available for the visualization of uncertainty.

### 2.2.3 Scale, generalization and base maps

In addition to the selection of visual variables, map design involves choices concerning generalization. Generalization is performed to reduce the amount of detail in a meaningful way (Kraak and Ormeling, 2003; Slocum et al., 2009). In essence, generalization results in simplifying objects on a map in various ways, or by deciding not to show them at all. A common example of generalization is the use of point symbols for areas, in small scale maps. Point symbols are then a generalization of areas, which may be visualized as polygons at a larger scale.

When maps can be viewed at different scales, as is the case with digital maps, the way the signs of which maps are composed interact may change. Users may zoom in to a map in order to interpret it at a local scale. They may attempt to locate a specific small town or parcel. When zooming in they expect to see more detailed information. This means that for specific scale ranges specific types or levels of generalization must be chosen.

Generalization is an issue for both the thematic information or map objects, as well as the base map. Base maps are made from large scale data stored in a digital landscape model (DLM), containing locations of towns, roads, waterbodies, etc. Generalization needs to be performed when the map is viewed at smaller scale e.g. a map showing the whole country. From the data in the DLM several cartographic representations are constructed. That way, base maps become more general as users zoom out and useful information is shown at each scale. Obviously, thematic information and the base map interact. The design and generalization of the base map may influence the interpretation of the thematic information (Förster, 2007; Förster et al., 2008).

This research does not focus on base maps, but on the thematic content.

As discussed in 2.1.4, viewing the thematic information in spatial plans at different scales can cause problems in the interpretation. A crisp line on a small scale map is fine if it is drawn at that scale intentionally. However, when it is viewed at large scale users might be tempted to draw conclusions at the level of individual parcels.

Generalization of thematic layers would involve choosing different graphic representations, or sets of visual variables for different scale ranges.

## 2.3 Maps on the Web

The rise of the Internet has reshaped the way people and organizations exchange information (Kraak, 2004). More and more, governments offer their information online. As we have seen in section 2.1.3, in the Netherlands the DURP project is a large initiative enabling the government to share spatial plans online.

In this section the concepts that define the process of sharing spatial plans online will be discussed.

The Internet is a large network of computers worldwide, providing the infrastructure for the World Wide Web, or simply the Web. The Web refers to the documents that are shared via the Internet, using protocols like HTTP. The documents are hypertext documents, meaning that they describe themselves according to standards and can be understood universally. The actual information is the content of those documents (W3C, 2009). Essentially, content is made accessible thanks to standards and protocols.

The Web has fundamentally changed the perspective on the role of maps (Kraak, 2004; Slocum et al., 2009). Traditionally, maps are used to represent a part of (designed) reality. On the Web, other functionalities can be added. Maps may be used as an interface for exploration and users can add their own content to it (Kraak, 2004). The possibilities will keep evolving as they have done over the last years. The change in perspective that was mentioned by Kraak, also indicates that people's expectations of maps have changed as a result of the new possibilities offered on the Web.

Obviously, different approaches for publishing maps on the Web exist. They can be classified according to their perception of the relation between client and server, or the user and publisher of the information.

The arrival of web services has added a new dimension to the concept of communication between clients and servers. Web services are self-contained, self-describing and modular (Sayar et al., 2006). Not only data captured in files, but a vast array of functionalities can be accessed online.

### 2.3.1 Maps and the Social Web

The Web has turned into a highly interactive and 'social' medium. The roles of publishers and users or consumers of information have become more intertwined. This is often referred to as the Web 2.0 or the Social Web. In GI, this calls for a strong consensus and mutual trust on issues like data quality and semantics (Bishr and Kuhn, 2007; Brinkhoff, 2007). The consumers' attitudes towards content on the Web, including maps, are changing (Kraak, 2004). It is now easy to access all sorts of maps on the Web and to add content to them. Some governments even offer personalized maps for citizens e.g. to view information about their building permits (Voorst, 2009).

### 2.3.2 Web Services

GIS applications by nature are large and demanding for the systems they run on. In web services, these applications do not run on the users system but on web servers where they can be accessed via the Web. Web services enable information to be accessed, exchanged and combined easily. The actual files (databases) remain stored on the server and are not actually exchanged. Clients perform queries on those files.

Web services, including web map services are built on what is called a Services Oriented Architecture (SOA). Rather than in one-to-one relationships, they typically exist in a network of related sites and portals, which is known as service chaining. Clients and servers communicate using standardized interfaces and XML specifications.

In web services, maps are to a large extent treated and dealt with as any other type of information. However certain aspects of maps, especially those concerning the visualization, make GIS still a unique domain in information technology.

In order to maximize interoperability and – ultimately – accessibility of geo information, standards have been developed, describing the various formats and interfaces in services and service chains. The Open Geospatial Consortium (OGC) is responsible for the so called open GIS standards and specifications (OGC, 2005).

The OGC specification for WMS (Web Map Service) has become a powerful specification for web mapping. It converts complex information (stored in files and databases) into imagery that can easily be included in Web pages. OGC offers other specifications for services as well, like the Web Feature Service (WFS). Here, maps are not just shared as images, but the actual features are retained as well. Creating clients for WFS is slightly more complex while performance is still rather slow.

More important from the perspective of visualization and styling maps is that are no significant differences. Both WMS and WFS maps can be styled using Symbology Encoding (SE). The application of SE in WMS is specified as the Styled Layer Descriptor (SLD). SLD allows clients to define styles for maps in XML documents. SE and SLD will be described in more detail in chapter 4.

Only a thin client (in fact only a web browser) is needed to extract maps from web services built on the WMS specification. However client applications vary in 'thickness' mainly depending on added functionality. Some clients are extensions to existing software packages. Some are lightweight web applications, which run on web servers and can easily be integrated in web pages.

The practice of web mapping does not always follow open standards or specifications. In fact some of the most successful applications of web mapping, like Google Maps, are developed in vendor specific formats.

So far the standards and specifications have not matured in such a way that they can handle every aspect of geo information. Various initiatives exist to extend their possibilities (e.g. Dietze and Zipf, 2007).

The visualization of uncertainty is still a challenge to the GIS community. Visualizing uncertainty in many cases involves the use of extended or advanced graphical variables (MacEachren et al., 2005). Some of these may not be fully available in OGC compliant web services.

### 3 Case study

The framework that was introduced in chapter 2, was based on findings from spatial planning and geo information science. It will now be used in a case study. This will show if the analysis of spatial plans, according to the three dimensions that were introduced in section 2.1.2 , can help identify issues surrounding uncertainty in spatial plans. The risks concerning the digitization of spatial planning maps are of particular interest to the research. Ultimately, the case study is performed to prepare for the design of a web based visualization, that will be discussed in chapter 4.

#### 3.1 Main characteristics of MJP2



figure 7, Agenda voor een Vitaal Platteland – Meerjarenprogramma 2007 – 2013 (LNV, 2006).

The Dutch national government has set up a program that aims at a “vital countryside”. It is laid down in the “Agenda voor een Vitaal Platteland – Meerjarenprogramma 2007 – 2013”, published by The ministry of Agriculture, Nature and Food Quality (LNV, 2006). It is mostly referred to as MJP2. MJP2 was chosen as a case for this research because it contains a set of maps representing the current practice of national spatial planning. It is

a compilation of national spatial plans, combined as a program. This compilation of plans offers a rich source of research material. The plans are of vital interest to organizations as well as individual citizens, each of whom perform their own interpretation.

A second reason to choose this case is the fact that so far the maps were only published as paper maps. (LNV) was hesitant to publish the maps in digital form, arguing the way the maps would be interpreted might not correspond to the intentions of the plans. It is a challenge to find out what will happen when the maps are published in digital form after all. Potentially, many of the issues surrounding uncertainty that were discussed above, will become visible in the process. Thankfully, digital datasets of the maps in MJP2 were made available by the ministry. This was an important condition to be able to perform the case study.

The demand for MJP2 originates from the changing character and use of the countryside in the Netherlands. Agriculture no longer is the only dominant function in the countryside. A new balance with other functions is sought. MJP2 describes goals for eight different themes including nature, agriculture, recreation and water management.

Several ministries are responsible for these themes and define policies for them. These policies are laid down in a number of spatial plans. MJP2 offers a structure for the coordination, planning, budget and monitoring of projects derived from these plans. In other words, MJP2 is not a spatial plan but a program set up to execute spatial plans. However, the content of those plans is vital to the program. This is why the maps of these plans are included in MJP2.

Provinces are strongly involved in the execution of the program, translating it into their own policies and planning. An example is “Vitaal Gelderland, Provinciaal Meerjarenprogramma 2007 – 2013” (Gelderland, 2006) of the province of Gelderland, which describes how this province plans to fulfill the goals set in MJP2. In short, the national government defines the goals and is responsible for legislation and funding, the provinces take care of the execution. This cooperative approach between governments can be considered as a manifestation of the national policy to decentralize if possible (VROM, 2004). Different ministries and provinces cooperate in a practical sense instead of merely working according to a hierarchy.

### **3.2 Analysis of maps in MJP2**

MJP2 contains a number of maps from Dutch national spatial plans. They are used by provinces and municipalities who need to interpret them and translate the policy into their own planning. Either directly or indirectly, all plans have an impact on the rights of individual land owners, farmers, companies and organizations with interests in the countryside. They have to be able to read and interpret the spatial plans in order to see the effect on their interests. In this section, the policy and the way it is expressed in maps and text will be analyzed.



As stated earlier, the main interest in the analysis of the maps is to identify uncertainty issues. The analysis is performed, using the framework from chapter 2. Statements on the three continua (jurisdiction, scale and impact) are made based on the available information and the actual maps. It is also important to establish the message of the map which is part of the expression of the policy. Clearly it is relevant to identify the audience for the plans. For all of the maps, the audience is very diverse as it includes planning professionals as well as citizens like individual land owners and others who have interests in the countryside. The analysis concludes by describing the features included in the digital dataset, from which the maps are made.

When all this information is gathered, the maps are reviewed from the perspective of uncertainty. In the following sections, both the analysis and the review are presented in a table for each of the three maps. Finally, risks following from digitizing the maps are identified if possible.

The analysis and reviews are performed on the versions of the plans as they were included in MJP2 (LNV, 2006). For some of them, the status has changed. Therefore the analysis also addresses the status of the plan, which can roughly be preliminary, final, or anything in between.

### 3.2.1 Map 3, Ecological Main Structure



figure 8 Map 3, Ecological Main Structure  
(Zoekgebied Nieuwe EHS, onderdeel robuuste verbindingen) (LNV, 2006)

The Ecological Main Structure (EHS) was designed to create a nationwide coherent structure for nature. First introduced in the early nineties, it is a complex set of regulations and agreements that are made operational in cooperation between the national and provincial governments. The main goals of EHS are to enlarge and connect nature areas.

It identifies areas for nature development and so-called solid connections between those areas. This will allow species to move around as much as possible. Also, the nature areas and values will become less vulnerable and the diversity of sorts will be enlarged (GroeneRuimte, 2009).

<b>Map 3: Analysis</b>	
Message	Display of areas for nature development known as the Ecological Main Structure and solid connections between those areas.
Audience	The primary audience are planners and related professionals involved in nature development at governments and politicians. The plan will affect individual citizens as well, so the general public is a secondary audience.
Jurisdiction	It is a national spatial plan, but the provinces are responsible for the final editions of the maps.
Scale	The scale of printed map is approximately 1 : 1.600.000. The EHS dataset was drawn at scale 1 : 10.000 (Streekplan Gelderland). Boundaries were defined at provincial and larger scales, in corporation with the provinces.
Impact	The impact varies according to local situations. There is not always a direct impact. Certain developments, like the construction of houses may conflict with EHS. However, developments may be allowed if they are compensated elsewhere within EHS. Goals are specified in percentages. If a certain part of EHS is developed as nature, other parts can remain in use for other functions.
Status	In itself, the status of EHS is nearly final. In some provinces some stretches of boundaries still must be (re)defined. The locations of the solid connections are to be to be defined by lower authorities, mostly the provinces. The policy must be integrated into local and provincial operational plans (streekplan, bestemmingsplannen).
Types of features	The map contains opaque green areas for nature areas, either planned or already realized. Orange lines represent search areas for 'solid connections' between nature areas. Bold yellow arrows with an orange outline again represent search areas for solid connections, only now they are labelled 'to be elaborated' (nader uit te werken).

Map 3: Review	
Uncertainty issues	<p>The scale of printed map is very small, whereas the boundaries of features are drawn at relatively large scale. It should be taken into account that the maps are often printed at larger scales, for instance when they are included in provincial publications. The way they are shown in MJP2 is problematic. Area features are visualized with a solid color fill. This causes them to seem more certain than they really are. One might conclude opaque green equals nature. Within the green areas however, different levels of certainty exist. Some areas are developed already, some don't require development (e.g. already a forest), others may be left out.</p> <p>The location of the line features appears more certain than it really is, because of the solid color and detailed location (drawn at large scale).</p> <p>The two types of solid connections represent concepts that are complex. The terms that are used require textual explanation. They are either "search areas" (zoekgebieden) or "to be elaborated" (nader uit te werken). Both terms indicate vagueness. Which one is the most certain is unclear.</p>
Effects of digitizing	<p>Some of the solid connections, the arrows, are drawn as point features. It is unclear if point objects are appropriate to depict a connection. Why not use a line here as well? This is a risk when the map is viewed in a digital application. The behaviour of point objects when zooming into the map requires special attention because it is quite different from lines and areas.</p> <p>For the areas the ability to zoom in is an advantage, because the objects are defined at a large scale. The opaque appearance can be problematic as it hides what is underneath.</p> <p>The connections that are depicted as lines are drawn as if they are final. This is a problem at any scale because this is not the case. Zooming to a larger scale will increase this problem.</p>

### 3.2.2 Map 10, Greenports and development areas for glasshouses



figure 9 Map 10, Greenports and development areas for glasshouses (Greenports en Landbouwwontwikkelingsgebieden glastuinbouw) (LNV, 2006)

Map 10 shows Greenports and development areas for glasshouses. Greenports are areas of national agricultural importance. Examples are the Bollenstreek and Aalsmeer areas, where the flower culture and trade takes place. Development areas for glasshouses are areas where large scale glasshouse complexes can be realized. Both are concepts of areas in which specific activities are to be concentrated.

<b>Map 10: Analysis</b>	
Message	Show the possible locations of greenports and development areas for glasshouses
Audience	Primary audience: planners and related professionals involved in nature development at governments, politicians. Indirectly the policy will affect individual citizens as well, so general public is a secondary audience.
Jurisdiction	National spatial plan
Scale	Scale of printed map is approximately 1 : 1.600.000 scale of dataset (at which it was made) is not specified. It is a small scale plan, showing the distribution of Greenports across the country.
Impact	The impact of the plan is strong. Certain areas are marked as greenports, others are not. There big consequences for local authorities and individuals who want to invest or start a business somewhere.
Status	The status of the plan is preliminary in the sense that some areas may eventually be left out while others can be added still. Also, the exact location of the sites are not specified yet. So, the plan needs to be developed further at provincial or local scale. This plan is only the first step in a series of plans.
Types of features	The map contains point features representing greenports (triangles) and development areas for glasshouses (pentagons). For the latter there is a subdivision of areas for which the policy is no longer valid (features without colour fill).

<b>Map 10: Review</b>	
Uncertainty issues	All point features represent areas. They are placed (presumably) in the centre of those areas. The actual size of the area can not be seen, possibly they are not defined. Some features are placed in built up areas (e.g. greenport Bollenstreek). It is certain that this location will not be developed as part of a greenport. This problem occurs when the map is viewed at larger scale (provincial or local).
Effects of digitizing	The main risk occurs when the map is viewed at larger scale. The map is clearly developed as a small scale map. Hence the choice of point features. When viewed at local scale, it is tempting to draw local conclusions, which can not be valid.

### 3.2.3 Map 15, National Landscapes

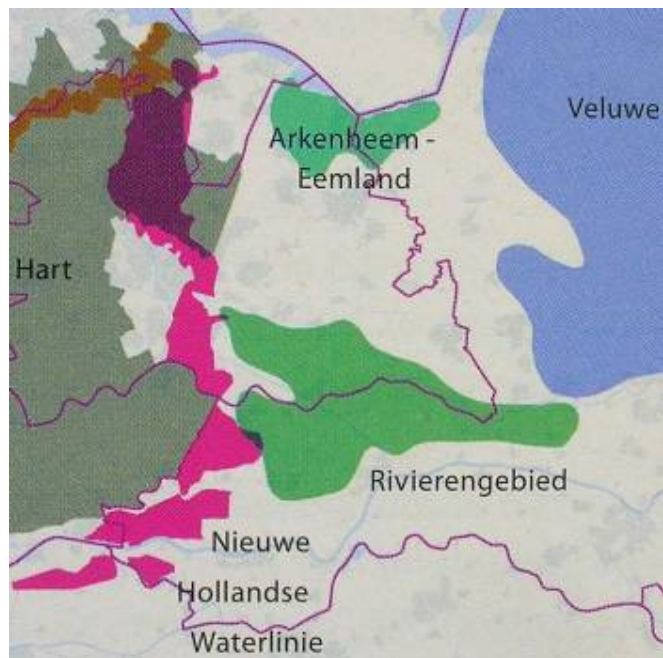


figure 10 map 15, National Landscapes  
(Nationale Landschappen) (LNV, 2006)

Map 15 in MJP2 shows the National Landscapes, representing the most important landscapes of the country. Unlike EHS, which focuses on nature, the National Landscapes combine characteristics from cultural heritage and nature. It serves a number of goals. The characteristics of the landscapes should be enhanced. Another goal is to create awareness of the qualities of the areas, for instance for tourism.

<b>Map 15: Analysis</b>	
Message	Show the distribution of national landscapes across the Netherlands.
Audience	The National Landscapes plan is one of the most 'public' plans of the national government. Its audience is very diverse. In the first stages of defining the areas, the people most concerned were local governments and individuals with interests in the areas. In its final form, the national landscapes are presented to the general public for touristic and other promotional purposes.
Jurisdiction	It is a national spatial plan. Lower authorities are involved in the definition of the plan.
Scale	Scale of printed map is approximately 1 : 1.600.000 Scale of dataset is not specified and it is not clear from how the map is composed. Boundaries of some features were defined at large scale (for those that have reached a more final status). Others, like the Veluwe area on the right in figure 9, do not yet have final boundaries. The map objects only roughly indicate the location of the boundaries.
Impact	Legal impact of the plan is not very strong. The plan does not contain very concrete restrictions for citizens. Goals are defined for areas but there are no strict regulations included to achieve them. Individuals who would want to invest in the areas, enhancing the qualities, have a strong interest.
Status	The status of the plan is preliminary. Some areas are final whereas for most the boundaries are yet to be decided upon at larger scale.
Types of features	Area features are all visualized equally. Solid color assigned per area (name of the landscape). Opacity is reduced allowing to view the base map underneath.

<b>Map 15: Review</b>	
Uncertainty issues	Features whose status differ are depicted the same. This is confusing. Preliminary boundaries drawn at small scale are crisp and may cause a wrong interpretation (when viewed at larger scale).
Effects of digitizing	Again the risks are very much scale related. As said, the scale at which objects are drawn, is not constant. So, when a user would zoom to a border at local scale, it would not be clear how crisp that line really is.

### 3.3 Uncertainty in MJP2

In chapter 2, a definition of uncertainty was adopted from Vullings et al. (2007), stating that uncertainty is the acknowledgement that one does not exactly know the situation of a system because of imperfect or incomplete information. To summarize the findings from the analysis in section 3.2, this section offers a more general analysis of the types of uncertainty that occur in the maps of MJP2.

The uncertainty in MJP2 can be described by a number of themes: concepts, scale and symbols. It could be argued that the uncertainty attached to these themes are examples of what the taxonomy refers to as “poorly defined” features.

#### 3.3.1 Concepts

Spatial policy, as any policy, is built up from a number of concepts. The same is true for the plans in MJP2. Concepts are components of a policy. Concepts are expressed as terms through a vocabulary or language. This enables people to communicate about these concepts. Problems can occur when concepts are expressed in terms that lead to uncertainty. Spatial plans may include objects which are labelled as final, preliminary, search areas or indicative. Especially in strategic plans, abundant use is made of those types of terms. Different governments use different terms. A specific, limitative set of terms, like those included in the standards for zoning plans (Geonovum, 2008), does not exist. In MJP2, some recurring terms are:

- Zoekgebied Nieuwe natuur (Search area New nature)
- Bruto EHS (Gross Ecological Main Structure).
- Greenports

For each of these terms, information is lacking what they imply for the objects they refer to. Understanding what they mean requires that the audience reads the text that accompanies the map. This text also requires an interpretation.

In some cases one reason for the uncertainty is that the consequences for locations are not clear until provincial or local governments have laid down a more detailed elaboration of the national policy.

An example is found in map 3 (page 26), depicting the Ecological Main Structure (EHS). Here, the borders are “final”. However, only a certain percentage of the area within those borders will be or should be developed as the EHS suggests.

In other words: although the status of a spatial plan may be final, the meaning of the plan is often indicative and – most importantly – described in unclear terms.

When viewed in a GIS, it is likely that zooming in to locations will make it harder to maintain awareness of the indicative nature of plans, especially if they are projected on detailed base maps (see also 3.3.2).

Another type of concepts used in spatial plans are geographic names. A location of a phenomenon is most often expressed by the location of a feature on a map. In certain



cases, the location is expressed verbally. This can be effective as long as the names that are used have a clear meaning.

As an example, in map 10 (greenports) in MJP2, we have seen point objects representing areas. These objects are labelled using geographic names, such as a name of a town (*Boskoop*), or an area (*Bollenstreek*). Clearly, the actual town of Boskoop is not to be developed into a so-called greenport. There is also some ambiguity connected to the name Bollenstreek. It is not clear at all where it starts and where it ends. Different users may have different opinions on this, causing uncertainty as to what the map makers mean.

### 3.3.2 Risks of digitizing, scale

The review of the maps showed that problems can occur if the maps are to be viewed in digital form. Most of those problems are in some way related to scale. Also, the problems mentioned in section 3.3.2 increase when the map is viewed at a larger (e.g. local) scale. The preliminary borders, like the border of the Veluwe area (figure 9), are obviously drawn at a national scale. Local situations are not relevant for the borders of these areas. When the areas are viewed as features on a map in a GIS, this is fine as long as one does not zoom to specific locations. When users zoom in, they may no longer see the shape of the object as a whole and are no longer aware of its intended scale. Second, when zooming in, more detailed information may appear on the basemap and users will be able to identify specific locations e.g. their own town or parcel boundaries. This may lead to wrong conclusions as the crispness of borders will be too prominent.

In order to be able to deal with scale related uncertainty, information about the scale at which features or objects were planned and intended to be valid is needed. This information is often incomplete or imperfect.

### 3.3.3 Symbology

In a number of maps in MJP2, symbols are used that have a certain ambivalence between their message and visualization. In map 10, point symbols are used to visualize possible locations for so called greenports and development areas for glasshouse agriculture.

They depict indicative areas, for which no precise location has been chosen yet. The size of those areas may be much larger than the symbols suggest. Also, the actual development might end up to be quite far from the symbol on the map, as some symbols refer (via their labels) to large regions while others refer to specific towns.

Symbols as described here contribute even more to uncertainty when used in a GIS. When users zoom in and view the map at a larger scale, the point symbols will remain points. It becomes even harder to see that they actually refer to areas. The potential impact on locations can not be read from the map.



## 4 Design

In this chapter alternative designs will be made for visualizations of the maps from the case. Visualization is considered as a solution for dealing with uncertainty in spatial plans, as suggested by Vullings et al., (2007).

In this case “dealing with” can mean two things: first, to give insight in the type and degree of uncertainty, to enable users to reach a correct interpretation. Second, to reduce uncertainty by developing a suitable visualization. As the Visualization Pipeline (Pang et al., 1997) showed, uncertainty can originate from the process of creating a visualization.

### 4.1 Design approach

Different types of uncertainty may influence the interpretation of the maps in MJP2. In some cases this uncertainty (or part of it) is intentional. This is obvious for strategic plans, which are intentionally indicative and need further elaboration and decision making. However the maps (the visualization) do not support an informed interpretation, which takes into account the level of uncertainty of the information.

When the printed maps are replaced by maps in a GIS, the process of interpretation will change. Especially when users view the maps at larger scales, it will be harder to maintain awareness of the meaning and status of the policy that is attached to objects on the maps. Most of the problems visualizing uncertainty are therefore in some way scale related.

At larger scales, it will be necessary to show more detail in the base map for orientation. This might have an impact on the interpretation as well. For this reason the thematic map can not be seen completely separate from the base map.

Polygons are the most common objects in the maps of MJP2. For polygons, two types of uncertainty were found in the maps. This uncertainty can not be read from the maps as they are.

For some objects the borders are clear, but it is not certain that the policy will be valid to the whole area (see EHS, 3.2.1). A variable showing the likeliness that the policy will be valid, is missing. This variable should be applied to the fill of the polygon.

Some objects are shown with crisp boundaries, while those boundaries are preliminary (3.2.3). Visualization variables could be applied to those borders. An obvious solution could be the use of fuzzy boundaries. Some variables aimed at the fill might also help to change the appearance of the crisp borders. A combination of variables might be appropriate.

Finally, much uncertainty arises from the concepts and terms used to express the status of spatial plans and policy. The language is confusing as various terms are used to describe different levels of the indicative nature of objects and plans.

#### 4.1.1 Scope

The design focuses on the visualization, which is part of the expression of spatial plans. The text of the plans will not be included.

The scope of the design can be defined more precisely, by looking at the elements the visualization is assembled. In a digital environment they include:

- base map
- one or more thematic map layers
- map behaviour for different scales like variation of the generalization

Additional aspects that strongly define how the digital visualization comes about are:

- viewer interface and functionality
- relation to textual information

All of these are subject to design when a spatial plan is published in digital form.

The design in this research will focus on the thematic map layers. On the other aspects statements or assumptions will be made if necessary from the perspective of the visualization.

#### 4.1.2 Requirements

From the research so far a number of design requirements can be derived. First of all the visualization should be a bivariate map, communicating at least two components of information present in the plans:

- the policy, being the content of the plan;
- insight into the type and degree of uncertainty.

The design is intended as an experiment to see how visualization can help convey information about the uncertainty in the spatial plan.

Also, the visualization should be:

- functional at scale ranges from local to national scale;
- understandable for audiences with little expert knowledge.

Defining a target audience in spatial planning is hard. For most national spatial plans, the main audience are professionals active in government and planning. These are the people most actively involved in the use and execution of the plans. Meanwhile, the plans may have impact on rights of individuals who have no expert knowledge. This discrepancy is a recurring issue in regulations and laws from all governments and their communication in general. Bearing this in mind it would be desirable for the design to aim at an audience which has little expert knowledge on spatial planning.

The visualization is to be shown online. This means that limitations of the web mapping application will influence the design results. For reasons explained in chapter 2, the OGC specifications for Web Map Services (WMS) and Symbology Encoding (SE) were chosen as the tools for web based publishing. They are therefore introduced as a design requirement:

- adhering to the OGC specifications WMS and SE.

Part of the research is the evaluation of these specifications. If necessary, initial designs will be developed before the final designs are made adhering to the specifications. That will allow for comparisons and evaluation. The initial designs will be made using an image editing application.

Finally, it is helpful to look at the results of the survey that was held among expert users on the subject of uncertainty in spatial plans, at the start of the Geo3 research project (Veen and Bloemhof, 2005; Vullings et al., 2005). These results can not directly be translated into requirements. They do however provide insight in the expectations of experts and they way they will use digital spatial plans in the future. The results of those surveys show that users have high expectations of the digital use of spatial plans. The possibility to view different plans in one application and see their relations is considered a great merit.

On the other hand many users are unsure whether uncertainty related to planning objects can be shown effectively in those applications. Many of these issues relate to the question whether digital applications should – to some extent – be used for the evaluation and control of spatial plans. For instance, it might be desirable to check a local zoning plan against a national spatial plan. In the survey, many users express their doubts on this topic.

This accords with the findings from the case: an effective way to visualize uncertainty is lacking. Beyond these results, information is scarce as to what the users require from the visualization.

### 4.1.3 Design set up

The material from the MJP2 provides input for the design. In addition to the MJP2 document itself, digital source material was made available by the Ministry of Agriculture, Nature and Food Quality (LNV). The material consists of GIS datasets in ESRI shape format for the thematic layers in the three maps that were used in the case.

Adherency to the OGC specifications was set as an optional requirement. Therefore the design process should be split in two. First, a conceptual design is to be developed without the restrictions of the OGC specifications. Then a final design is made in a web GIS application, applying the specifications. The two resulting designs will be compared to evaluate the suitability of the specifications for uncertainty visualization.

To fulfill the requirement that the visualization should work at all scales, scale ranges must be specified, for which different visualizations may be designed. A practical approach is to stick to the three levels of government in the Netherlands and find fitting scale ranges for each of them. The following division is proposed:

	Indication of the scale ranges
National	1 : 100.000 or smaller
Provincial	1 : 10.000 – 1 : 100.000
Local	1 : 1.000 – 1 : 10.000

table 5 scale ranges that were applied to the three maps from the case

## 4.2 Styling maps using Symbology Encoding (SE)

The styling options offered by the OGC specifications will be analyzed to see how they can help create a visualization for the maps from the case. Then designs will be made and implemented in an OGC based Web map viewer. Finally a number of alternative solutions are discussed. This is done to evaluate the possibilities of OGC based visualizations and see which opportunities might be there to further enhance those possibilities.

### 4.2.1 WMS combined with Symbology Encoding (SE)

As discussed in section 2.3, WMS is the OGC specification for publishing Web maps. The styling of the maps can be defined using a combination of WMS and Symbology Encoding (SE). SE is a styling language which allows users (clients) to define the style of maps. SE can be applied to WMS, WFS and WCS servers. Styled Layer Descriptor (SLD), or rather the SLD profile defines how SE can be combined with WMS (OGC, 2006; two specifications). SE and SLD were previously only known and specified as SLD. SE can also be combined with WFS (Web Feature Services).

The concept of SLD is that content and presentation of information are defined and stored separately. This allows for both of them to be edited and used separately. This is similar to how HTML documents on the Web can be styled using Cascading Style Sheets (CSS), according to the specifications of the World Wide Web Consortium (W3C, 2009). Both with CSS and SLD, the client defines which styling is applied to the content, i.e. textual information or maps. In general, the client is a website which may include content from various sources i.e. Web services.

#### 4.2.2 Styling options offered by SE

Symbology Encoding offers options for the styling of layers within a Web map service. The options are described in the Symbology Encoding Implementation Specification (OGC, 2006). SE lists five Symbolizers, which may be subject to styling:

- Line (stroke) LineSymbolizer
- Polygon PolygonSymbolizer
- Point
- Text
- Raster

The PolygonSymbolizer has two sub elements: Stroke and Fill.

The Stroke element supports the same type of styling for the contour of a polygon, as if it were a line feature.

- Color
- Width
- Dash array
- Opacity

The Fill element supports styling for the fill:

- Color
- Opacity
- Hatching
- Graphic fill using Marks (defined as WellKnownName: circle, square, triangle, star, cross or X)
- Graphic fill using images. These image files may be stored and referred to either on the server or any location on the web via URL. For the images, several file formats are allowed including GIF or PNG which allow transparency.

Transparency and opacity are two different things in this context. A graphic fill can be transparent meaning that it does not completely cover what is underneath because there are holes in the fill. For example, a raster image can be tiled as a fill. Parts of the image may be transparent.

The Opacity element defines to which degree a fill (or any Symbolizer) hides what is underneath. If the value for opacity is “1” the fill is opaque. For other, lower opacity values the fill will appear like a translucent sheet on the map.

The TextSymbolizer allows for labelling of features according to attributes.

There are two more tools to create specific styles for maps:

- The ScaleDenominator lets users define different visualizations (defined as Rules) for different scale ranges.
- Filters are used to style features according to attribute values. Essentially they are queries which only visualize a selection of features. When Filters are combined, they can be used to style features within layers differently according to attribute values.

#### 4.2.3 Styling maps (for uncertainty visualization) using SE

To test the various options for visualization offered by SE, two datasets from the case are put in a Web map viewer.

The viewer is constructed using OpenLayers, a Javascript library for displaying map data in web browsers. OpenLayers supports the WMS and WFS protocols of the OpenGIS Consortium. The OpenLayers API (Application Programming Interface) enables Web developers to integrate map clients in Web pages, without server side dependencies (OpenLayers, 2009).

To integrate the viewer in a Web page, two steps are required:

First, in the head of the HTML document, a link must be included to the OpenLayers code, found at the OpenLayers Web site.

Second, in the HTML document a segment of code written in Javascript is written as commands for the API, specifying what will be displayed in the viewer and how. The segment contains URL addresses of the data services and parameters for various visualization settings, including controls, the initial viewing location and zoom factor.

The fill of features can be customized very well using SE. Visualization variables that were suggested in chapter 2, are supported:

- **Saturation** can be set using the hexadecimal color scheme, which supports 16 million colors.
- **Texture** can be fully customized by using raster images as a graphic fill. The image may be transparent if it is in GIF or PNG format. This allows for any pattern.
- **Transparency** can be set in the SLD file for values between 0 and 1, using the Opacity element.



Similar options are available for the borders of features, but they are less useful for the visualization of uncertainty, as described in the design phase. Some key options are missing:

- **Crispness** of borders can not be adjusted. Gradients of opacity or color are not supported.
- The use of **resolution**, like the aliased appearance of borders is not available either. This would require adjustments to the actual datasets.

Using the options that are available, border crispness can be simulated to some extent by varying the borders opacity, while using a thick border (stroke). If the opacity of the border is set lower than the fill (using the same color), the feature gets a more fuzzy appearance.

Applying this styling proved problematic. It showed that the thicker border has an overlap with the actual fill, with a higher opacity.

As a variation, the opacity of the fill could be dropped to zero, leaving only a contour visible. This may cause features to be mistaken for line features, especially when only part of a feature is in the view.

Some examples of these options for visualization are shown below.

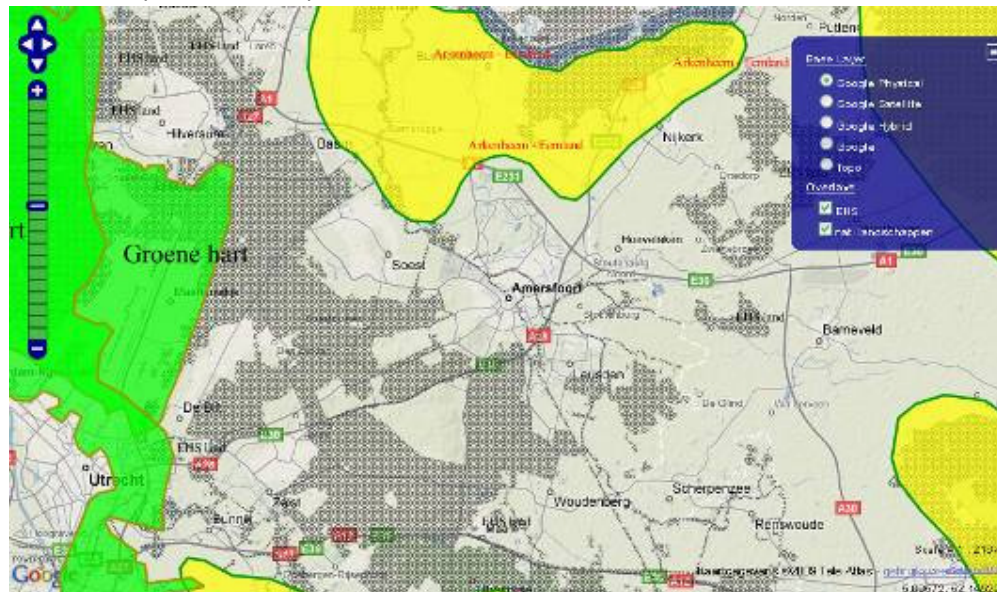


figure 11 data for EHS and national landscapes displayed on a Google Terrain base map, styling is just a first try out to see the effect of different parameters and settings. EHS is represented as using a tiled GIF image which is transparent in part. The coloured polygons are national landscapes. For all objects, the opacity is lowered, revealing what is underneath.



figure 12 EHS with a higher opacity, shown on the Google Street map.



figure 13 The national landscapes differentiated according to the status, either preliminary or fixed boundaries. Overlap of stroke and fill causes the opacity to increase.



figure 14 Variation on the previous visualization with opacity set to 0. Arguably, this can cause confusion when only part of an object is viewed. The border will appear as a line object. It is unclear to which side the actual area is.

#### 4.2.4 Implementation in Open Layers

The WMS service was hosted at Delft University. Geoserver is installed there. It supports the use of SLD stylesheets. In Geoserver, the datasets are stored on the server. Styles can be defined by attaching SLD stylesheets to the datasets. The stylesheets can be edited via a web interface. Apart from some basic settings, Geoserver only supports editing through typing the code in a basic texteditor.

The web maps were then included in a web page. In the web page, requests are sent to the map server via Open Layers using javascript. Open Layers makes it possible to include a dynamic map viewer in a webpage. In the head of the html code there is a link to the javascript API at the site of openlayers.org. Then, at the place of choice in the body of the page, the map can be combined from WMS services and base layers. Base layers in this case were requested from Google (physical, satellite and hybrid). Parameters can be set for choosing which layers are on initially, the zoom rate and location coordinates. The viewer includes a menu for toggling layers of and on. The maps from the WMS service in Geoserver is received by the viewer in tiles. If the response from Geoserver is slow, sometimes a few tiles are left out. This is called a time out.

The relevant html code in which the javascript is embedded in the html can be found in Appendix 2.

The web page also includes the survey. This will be discussed in chapter 5.

### 4.3 Design for the 3 maps

This section describes the design choices that were made for the three maps. Selection of visual variables.

#### 4.3.1 Ecological Main structure

This map actually consists of two datasets, one for the actual Ecological Main structure areas and one for the solid connections.

As was found in the map analysis and map review, the opaque areas conflict with the content. It would be better to show that not all that is green is in fact nature. The boundaries are more or less final. They were in fact established at provincial scale. This in itself is a confusing characteristic of EHS, which is after all a national plan.

A solution to show the uncertainty is to replace the opaque polygons with polygons to which the grain (texture) variable is applied. It is hard to create a scale for this, since there is only one type of feature, with one level of uncertainty. This would make the use of other variables less effective as there are no objects to compare to (figure 15).

The opaque green is replaced by a pattern which indicates that within the area, location may or may not be developed as nature. Various options were tried out (see figure 11 and the images from the survey). For the SLD, coding proved straightforward (see appendix 1) using only the styling for the polygon fill.



figure 15 Data of map 3 EHS (MJP2) shown on a large scale topographic map (found at KICH.nl) using Photoshop for image processing. Although the transparency helps to see that all that is green may all be nature, comparisons are not possible because there is only one type of EHS area.

The data for the solid connections proved to be rather complex. Looking at the paper maps, object seem to be point symbols (the arrows) and line symbols (orange lines). In the dataset, both are defined as polygons. The lines being a sort of buffer, presumably drawn around a line. The arrows being areas drawn to look as if they were icons. To be

able to apply a different visualization, the data itself had to be changed. The shapes of the polygons were too dominant to be able to style them properly. As they are in essence connections (between EHS areas), lines would seem the most fitting. It proved to be feasible to replace the polygons by line features. Again there are not very many objects that can be put projected on an ordinal scale. Both types of connections are uncertain in terms of their exact location. The term 'solid connection' does not refer to a very clear concept. Styling was therefore problematic. The final design involves a combination of the use of transparency and grain, applied to the lines. Line features were stacked in the SLD to give them a white border. The purple colour was chosen to make the objects stand out from the background and EHS greens. This is similar to the choice of yellow and orange in the original maps.



figure 16 Fragment of the final EHS alternative map showing EHS area and a solid connection. Visible is how one tile of the solid connection layer is missing, because of a time out.

#### 4.3.2 Greenports

As was seen in the map review, the points symbols used in the original greenports map are only effective in small scale maps. Viewed at local scale, their position is not correct. A solution was found by introducing larger symbols, icons that are included in the map from raster images combined with half transparent squares. Both symbols are centered on the point and should suggest that the greenport (or the development area for glasshouses) is not necessarily located exactly on the spot of the point data. In the symbols. This is further enhanced by the use of arrows in the symbol. The symbols are larger when the user zooms to provincial and local scales.

Apparently because of time outs, parts of the tiles are missing. This might be caused by the fact that the SLD includes the use of an image file on an external server. If that is received too late, Geoserver can not send the combined WMS image to the Openlayers application in the web page.



figure 17 Fragment of the final Greenports map showing the proposed point symbols. Tiles are missing at the bottom of the image.

#### 4.3.3 National Landscapes

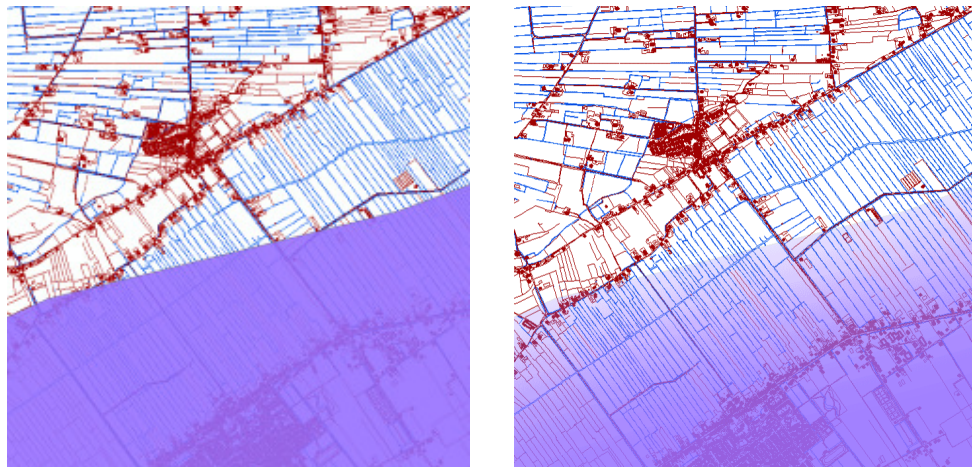


figure 18 Data of map 15 Nationale Landschappen (MJP2) shown on large scale topographic map (GBKN) using Photoshop for image processing.

The national landscapes map in MJP2 contains two types of objects, included in one shape file. Borders of some areas (polygons) are final some are not. In MJP2, they are visualized the same. In chapter 3, this was discussed. This is the only dataset in which objects of a different level of uncertainty are included. The differences between the objects can be visualized. As the uncertainty concerns the borders, the use of the crispness variable stands out as the most appropriate. A fuzzy border indicates if a border is not final. If a border is final, it can be depicted as a crisp line or edge. In MJP2, all edges are crisp. Figure 18 shows how a crisp border for an area is not appropriate when the status of that border is not final. It can cause false interpretation, suggesting that locations in this particular area are either inside or outside the national landscape. A

fuzzy border, as shown on the right, can help to understand that the exact line is not that final yet. As stated above, SLD does not include tools to make fuzzy borders. Therefore, experiments were performed to simulate them (figures 13, 14 and the survey). As an alternative, a solution using symbols from image files to indicate that a border is not that crisp was tried as shown in figure 19.

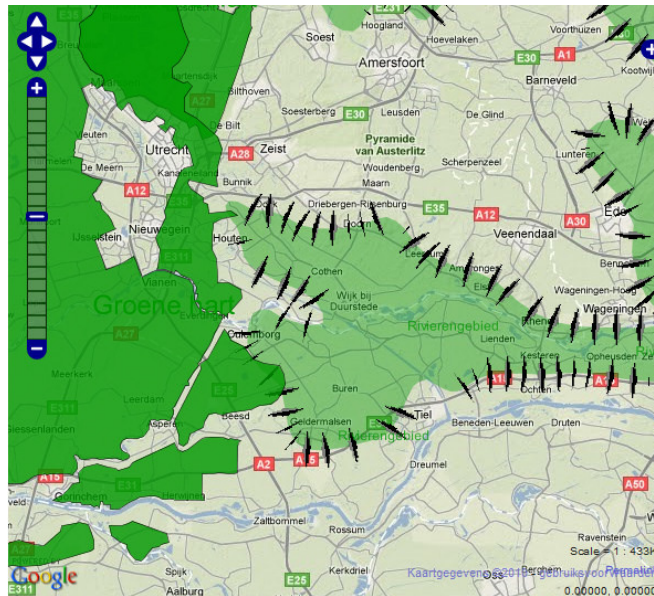


figure 19 the use of image files on a border of national landscapes.

This technique could be effective in theory. The resulting images are not attractive. The raster images are disfigured and aliased. The interval between them is not constant. The images may also be displaced if the border in the dataset is not drawn as a smooth line. This is caused by the characteristics of the dataset, which is small scale and rather crude when viewed large. In the final map, fuzziness is simulated by stacking elements with different levels of opacity and border width (see map in survey and appendix).





## **5 Survey**

As the final step in the research, a survey was set up. The design results were put online accompanied by a questionnaire. The survey deals with certain aspects of the research. Roughly, the survey focuses on three questions:

1. Evaluation of the design results: how do professionals judge the alternative visualizations?
2. More generic, do experts agree that uncertainty should be visualized when publishing spatial plans online? The survey also addresses some of the issues that are raised in the process, like the role of scale and base maps.
3. Are the OGC specifications WMS and SE/SLD suitable for the visualization of uncertainty?

The results should help to verify if the framework that was introduced in chapter 2 can be applied in practice. Can it help to address the uncertainty issues that were identified in the case? Before analyzing the survey results in section 5.3 below, the setup of the survey and the main results are introduced.

### **5.1 Survey overview**

The survey was published in Dutch as the target audience consists of professionals in planning in the Netherlands. The opening screen shows a short introduction to the survey. On the next page, a map viewer and the green survey window are shown side-by-side. At the bottom are links to scanned images of the original maps from MJP2. All of these are put in one screen allowing users to complete the survey without leaving the page or being required to open more than one application window.

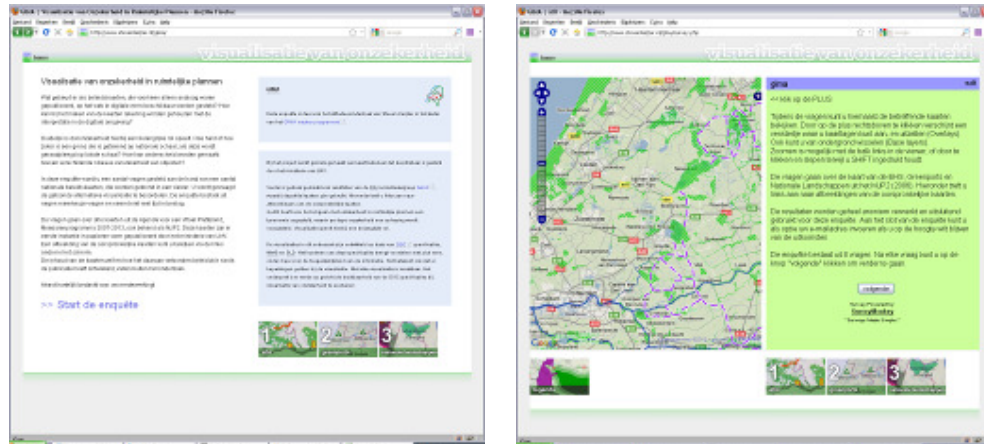


figure 20 opening screen and main page of the survey (see appendix for large format).

The three elements (map, survey, original images) are dynamic to some extent, enabled by javascript. This may have caused the technical difficulties experienced by some. The survey was tested successfully in recent versions of most common web browsers including Internet Explorer, Firefox and Opera. Errors were reported by people using Google Chrome.

In the survey, respondents are asked to review the three maps after viewing them at local, regional and national scales. Also some general questions are asked about the concepts of scale, base maps and map comparisons. Finally, they are asked if they believe that a standard can be developed for the visualization of uncertainty. For all questions there are four or five predefined answers. Additionally, respondents can type their own answer or enter a comment.



figure 21 Sample image of a map taken from the survey. The map shows parts of two national landscapes near Hilversum at local scale. Both on a vector map (Google Physical) and aerial photograph (also from Google) are shown as base map. Images of all maps are found in Appendix 1.

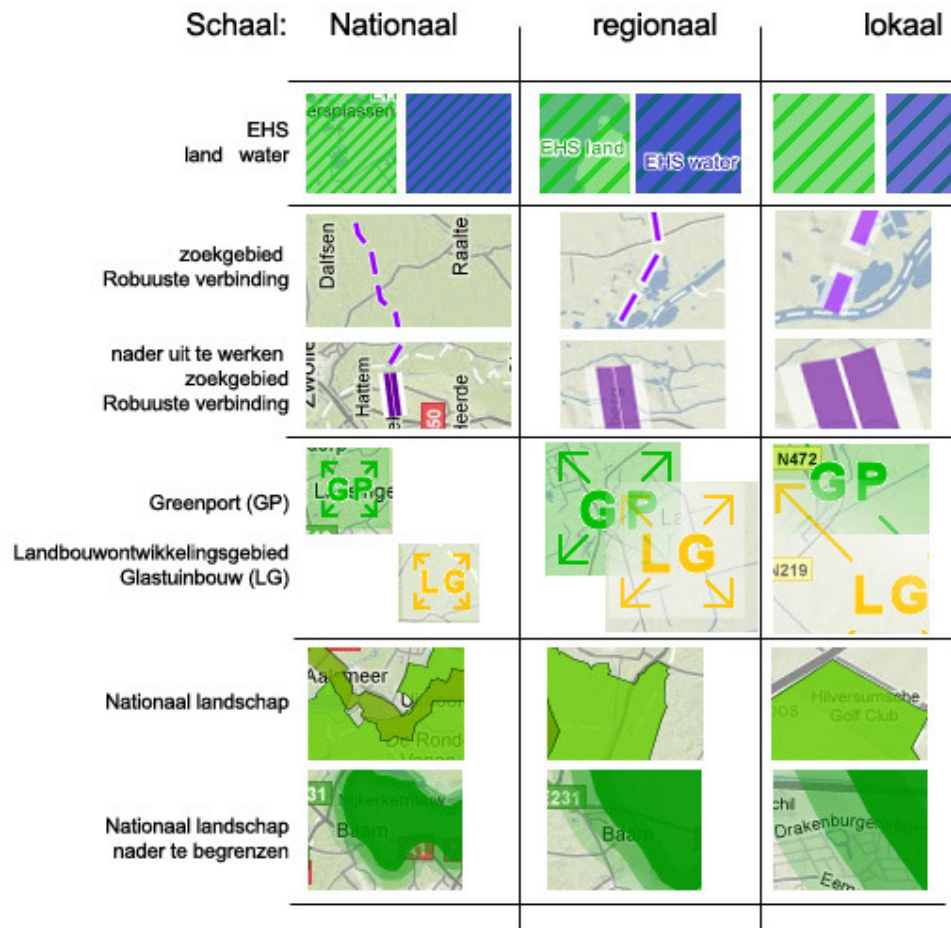


figure 22 key for the maps reviewed in the survey

The survey was held in May 2010. The respondents include planning professionals from all levels of Dutch government, as well as those active in companies that offer services to governments. Mostly they are people in planning agencies or software developers (results for question number 9). In total, 35 people responded, 27 of which completed the entire survey. Some of those who did not complete it reported they were not able to operate the map viewer.

## 5.2 Results for the three alternative maps

First the results for the maps from the case are summarized here. For all three maps, respondents were asked to evaluate the alternative map. Full results to all questions can be found in appendix 1.

### 5.2.1 EHS

For the EHS map, 50% of the respondents that were able to view the maps said they agreed the alternative map offers more information and that the information is clear. The other 50%, (16 out of 32) consisted of people who were neutral, skeptical or negative. Some remarks were returned that help to identify the relevant factors in the outcome.

- the dashed lines used for the solid connections that are yet to be defined, were considered confusing. The same was said about the hatched EHS areas. According to some respondents, the image becomes messy.
- One respondent commented that the purple colour for the solid connections should be green. Possibly, because the theme of the map concerns nature, purple seems too exotic.
- Some respondents found difficulty in comparing the maps. Some could not find part of the information, like the map key or the original map.

### 5.2.2 Greenports

The second question is about the Greenports map. 28 valid responses were returned, 17 of which were positive about the comparison. However, the less favourable responses point out a problem in the map design. The icons (point symbols) that were used for the greenports were considered unsuitable for the theme. The arrows in the symbols that are pointing outwards, were meant to indicate that the location of the greenports need not be on the exact spot of the point data. However, some respondents argued the arrows should point inwards because greenports are areas of concentration. This is an important goal of the policy. More generally, the results show some ambivalence about the quality of the alternative map. One respondent indicates that he has become used and attached to the original paper map. The alternative map looks less attractive.

### 5.2.3 National Landscapes

For the alternative map of National Landscapes, most responses were positive. Some responded that the fact that different shades of green were used for the landscapes was confusing. One suggested that the colour should equal for all objects. Variations should only be applied to the border. Also, the dark colours of the uncertain landscapes are considered confusing. According to some, dark colours indicate certainty, brighter colours should be used for less certain objects.

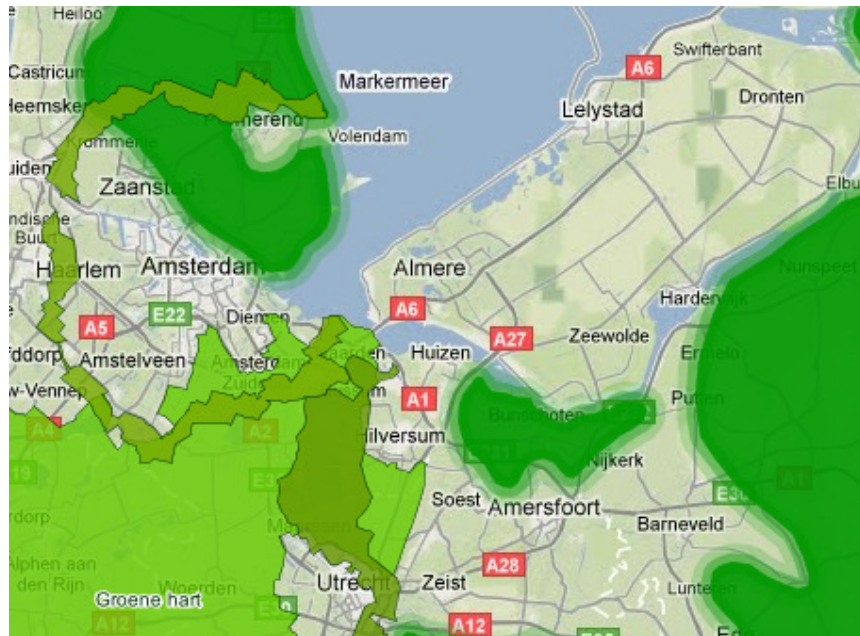


figure 23 Sample image of the map showing National Landscapes at national scale.

#### 5.2.4 Results for the general questions

Questions 4 until 8 in the survey deal with more general issues concerning uncertainty visualization, not referring to the specific maps.

In question 4 respondents were asked if they approve of the idea to adjust the visualization to the scale at which it is viewed. A majority of about 60% agreed that this helps to understand that the effect of a spatial policy depends on the scale at which it was developed. Another 20% would prefer to take it one step further: only show the plan at the scale at which it is developed.

Question 5 deals with the basemap. How do respondents appreciate the fact that the basemaps (from Google) show more detailed information when users zoom in? Responses to this question are ambivalent. Some argue: the more information, the better. Others acknowledge a conflict between the scale of the thematic map and the basemap. The option that detailed basemaps lead to artificial accuracy got the most votes, 11 out of 27, just over 40%.

Answers to question 6 show that most respondents agree that it is a merit if spatial plans from local and national governments can be compared in one viewer. This option was not offered in the viewer, so it was hypothetical. Some responses are hesitant for this reason. 12 out of 26 agree that is important to know about the scale and the origin (jurisdiction) of the plans. One respondent points out that there is a difference between lay users and professionals in the ability to understand these differences.

Answers to question number 7 show that nearly all respondents (23 out of 25) agree that it is desirable to include information about uncertainty in the visualization in some form. One respondent suggests this should be included in the RO standaarden (Dutch standards for the publication of spatial plans, see section 2.1.2). This remark connects to the final question.

In question number 8 respondents are asked if they believe that a standard can be developed for the visualization of uncertainty in spatial plans. Most popular response by far (17 out of 27) is the option that it is possible, provided that there is an agreement on terms and definitions for levels of uncertainty. One respondent argues that the maps may become too complicated to develop. Three respondents believe the diversity among plans rules out standardization. Four respondents believe that standards are a threat to the freedom to develop a policy.

### **5.3 Analysis of the survey results**

An analysis of the survey results is needed to find out what these results mean from the perspective of the research. This will shed more light on the research questions and the framework that was introduced in chapter 2.

#### **5.3.1 Evaluation of the maps**

Although on average the reviews of the three alternative maps are positive, many respondents express their doubts about the way uncertainty was visualized. Some responses are clearly negative. The comments that were made indicate a number of reasons for the ambivalence.

First of all the designs were made as experimental visualizations, focusing on uncertainty. The maps were taken out of their usual context. As was found in chapter 3, the meaning of a map can not always be established without textual explanation. Only the visualization was used here as a solution, so that issue remains. The restrictions of the OGC specifications have influenced the visualization design. As was shown in chapter 4, this proved an obstacle to achieve an optimal design. Some visualization variables are not available using the specifications. Although this was mentioned in the introduction to the survey, respondents are not likely to be aware of the impact of the limitations.

Another element of the experiment is the fact that users can zoom in to the map. This causes some of the national maps to look unfamiliar. For instance the point symbols in the greenports map cause difficulty in the transfer to large scale views. The user's perspective matters as well. Planning professionals are familiar with the maps that were used in the case and with the content of the plans. They have learned to understand the plans as they are and to look beyond the supposed imperfections of the way the plans are expressed. The designs look unfamiliar and take a different approach to certain aspects of the plans. One could say through the years the policy and its

expression have become entwined in the minds of the users. Anything that deviates from that may cause some ambivalence.

Finally, some design choices like the use of purple dashed lines for the solid connections caused ambivalence in part by the lack of semantic recognition. For certain aspects, a more conventional approach to the design could have led to better results.

A number of the principles used for the visualization were received with consent. An example is the idea to add fuzzy boundaries to the uncertain national landscapes. This confirms that the use of fuzzy boundaries is a valid way of displaying uncertainty on a thematic map object. Generally, there was hardly any discussion about the fact that uncertainty was included in the visualization, by means of a bivariate map.

### 5.3.2 Suitability of OGC specifications

The fact that the designs were made based on OGC specifications, put certain limitations on the results. The set of visualization variables is limited. One variable was missed in particular: the ability to create fuzzy borders on areas, which is an application of the variable of crispness. In the alternative map for National Landscapes, fuzzy borders were simulated by duplicating the borders in different levels of transparency. Although not perfect, especially at large scales, some respondents thought it was effective.

Most other variables are available in WMS, combined with SE through SLD. As was discussed in chapter 4, the possibilities for styling polygons (area) are extensive. This is a great merit for spatial plans which typically comprise many area objects.

The ability to define scale ranges is also an important condition to be able to create a good translation of the original maps. In this case three scale ranges were defined, each of which had to be programmed in the SLD style sheets. It was noted by some respondents that maps looked messy at certain scales. It is true that near the edge of the scale band width that styles were defined for, some objects looked a bit odd. In other words, it might be better to define more, shorter scale ranges. This also means that the style sheets will become more complex and defining styles requires more effort.

An important point is the fact that apart from the application and specifications, characteristics of the data also determine the outcome. The data was stored in ESRI Shape-format (shp) and it was small scale data.

### 5.3.3 General questions: evaluation

As said, the survey results support the statement that it is desirable to display uncertainty in digital spatial plans. A large majority agrees. Comments focused on 'how' rather than 'if' it should be displayed. Although the term uncertainty was not introduced extensively, only a few respondents asked what was meant by the term. This indicates a certain level of awareness of the issue of uncertainty prior to the survey.

The results on the topic of scale confirm that this is a vital issue. This corresponds with the findings from the research. In the alternative maps, all data were shown at all scales. This was done also to find out if respondents would object to it. Some respondents argued that national data should not be shown at local scale. This is an interesting issue that is not yet resolved. As an example: for the greenports, it is hard to display the objects at local scale in a meaningful way. Ironically, the local impact may be very strong. Individuals searching for information about national plans in and around their town, should like to know about those plans as well.

Because the survey only dealt with national plans, the issue of scale was not addressed for local plans. A few remarks can be made though. Here, the problem is a less complex. There are not many meaningful ways in which to display a local plan on a map showing the whole country. It would automatically be reduced to a dot or a small icon and nobody will bother to try to interpret the plan.

Obvious as this may be, there is a similarity in the interpretation of national plans at local scale. For example in the case, the visualization should carry an important message about the validity of the spatial plan at that particular scale.

The responses to the question about basemaps show no consensus as to whether or not it is a problem if the basemap shows too much detail at large scale. Most respondents prefer to trust the map user to make the right interpretation. Also, the responses indicate that it is more important to focus on the thematic data, as discussed above. Obviously, the interaction between both will influence the interpretation. On the other hand basemaps are mostly no part of the actual plan. The map publisher will not always be able to control on which basemap a plan will be shown.

The survey shows that respondents have confidence that standards can be developed for the visualization of uncertainty. Only a few fear that the freedom of policy is at stake. Most respondents acknowledge the need to agree on terms. This corresponds with the findings of the research. It proves that there is a lot of work to do, seeing the wide variety of concepts and terms concerning uncertainty, that are used in plans.



## **6 Conclusions and recommendations**

To conclude this master thesis, this chapter presents the conclusions and recommendations resulting from the research project. The first section (6.1) returns to the research objectives and research questions, as they were defined in chapter 1. Then, the conclusions are presented in section 6.2. In the final section a number of recommendations are given.

### **6.1 Research objectives and research questions revisited**

The research objectives and research questions were defined from a designers perspective. They suggest that the end result should be a set of maps in a digital application. It is true that maps were made and they were put in a web map viewer. The focus of the research however has shifted slightly towards more theoretical areas. The design process was made slightly less elaborate. One original goal was to split the design process in two: first, to design a visualization without taking into account the OGC specification. Second, to translate that design into a WMS and SLD based visualization in a web map viewer. Instead, the first step was reshaped into a more theoretical approach. This would serve as better input for the final design. Objectives A and B, the design of a visualization and its implementation in a web map viewer, have become more integrated than originally planned.

Research questions A1, A2 and A3 were answered in chapter 2, sections 2.1 and 2.2. Research questions B1 and B2 were answered in part in section 2.3 and in chapters 3 and 4. These results were used in the design, which was evaluated in the survey. All results are presented here.

### **6.2 Conclusions**

Based on the literature study, in this research spatial plans are considered as spatial policy that is expressed through maps and text and to which a number of continua apply. Continua, policy and its expression are three dimensions of the entity of the spatial plan (figure 2). This concept served as a framework for the methodological approach (section

2.1.2). It was used in the case study and design to identify and locate uncertainty in spatial plans.

By nature, uncertainty is present in spatial plans. Part of it can not be separated from the content. It is often intentional, related to the fact that spatial plans present a designed, possible reality instead of reality as such. This is how spatial plans differ from most other types of geo information, where uncertainty is often defined as a problem in terms of data quality. A definition for uncertainty was adopted from Vullings et al. (2007):

*Uncertainty is the acknowledgement that one does not exactly know the situation of a system because of imperfect or incomplete information.*

This allows for uncertainty to be intentional. For instance, information may still be incomplete when a plan is published (section 2.1.4).

Visualization is part of the expression of spatial plans. The visualization is a powerful tool for dealing with uncertainty. It can reduce uncertainty in the interpretation as well as contribute to it. It can give insight to the nature and level of uncertainty (section 2.2 and survey). The survey corresponds with this conclusion. It shows that planning professionals are confident that uncertainty can very well be used to display uncertainty

Information about the continua is vital for a correct interpretation of spatial plans. It can best be described in the plan's metadata, because it explains how the policy should be interpreted. The three continua were not intended as a limitative set of metadata, more metadata may be added to a plan, for instance about the plan's status. The three continua are special because they define part of the policy of the plan (section 2.1.2, case and survey).

In a digital environment, the characteristics and impact of uncertainty change. This calls for an alternative approach to the design of the expression of spatial plans. Most of all, the issue of scale is crucial. For small scale plans, a number of design choices arise. First of all, governments should decide whether the plan will be made available for viewing at larger scales. In applications and or SLD style sheets, certain scale ranges may be blocked. However, in practice, local governments and individuals will expect to be able view a plan at local (large) scale, or in fact at any scale.

The second option is to make different visualizations per scale range. A downside of this option is the extra amount of work that needs to be done and the complexity of the results.

The different designs imply different levels of generalization. Generalization of thematic objects is tricky. It is a challenge to make sure that no contradictions occur between the visualizations for the different scale ranges (chapters 4 and 5).

In theory, the problems of viewing a large scale plan at small scale, should mirror the ones listed above. In fact, there is no real problem because a large scale local plan can not really be interpreted from a small scale map showing the whole country. Still, problems can occur for instance when a local plan is compared to a national or provincial

plan. This often happens when a ministry or province judges a local plan, from the perspective of their own small scale plans. If any problems occur, the interpretation of the small scale plan is the most crucial, as the interpretation is performed at local scale. In that sense, the local plan can not be 'wrong' (chapter 4).

It can be a challenge to develop a visualization of uncertainty in bivariate maps using the WMS and SLD / SE specifications defined by the OGC. This depends on the design choices and the characteristics of the data.

In SE, support for styling of areas is very extensive and can be customized in various ways using raster images, transparency and other variables. Also there is support to define any number of scale ranges, to adjust visualization to different viewing scales. For the styling of borders, there are some problems. The main problem that occurred in the design process is how to vary the crispness or fuzziness of borders. This is a special type of styling as it actually affects the area itself as well. This is not supported in SE. It can be simulated by stacking areas with varying border thickness and opacity (as shown in chapters 4 and 5, national landscapes), but the results are not effective at all scales. Also, the result of stacking is that each object needs to be defined several times. This can lead to long and complex style sheets, especially if scale ranges are defined.

Another issue was found when series of small image files (icons or similar raster image files, e.g. in png format) were used for border styling. In theory this is a very effective technique. The resulting images are not attractive. The raster images are disfigured and aliased. The interval between them is not constant. The images may also be displaced if the border in the dataset is not drawn as a smooth line.

The design and survey showed that small scale data can look messy or crude when viewed at large scale. In itself this is quite logical. In order to be able to create attractive visualizations at larger scales, it may be necessary to optimize the data for those scales. All in all, in its current status the specifications from OGC can only be really effective if the objects have crisp boundaries. This rules out a number of visualization variables for uncertainty.

The survey shows that there is a potential for the definition of standards for visualization of uncertainty, similar to standards that are already included in the RO Standaarden (Geonovum, 2008). The DURP project has shown that standards are a condition if users want to be able to compare plans. Seeing that more plans are made available in digital form, people are likely to make comparisons by viewing different plans in one application. The need for standards is therefore becoming more urgent.

The standards can only be defined if agreement is reached on terms that are used to define uncertainty in words. Those terms refer to concepts that constitute spatial policy. As seen in the case, there is quite a variety in those terms. This will require quite a lot of debate.

Related to these terms, are the geographical terms. Especially the Greenports map shows that there can be an inconsistency between the geographical names that are used and the actual locations they refer to. The example of the Bollenstreek stands out.

The objects in the maps from the case do not represent many different levels of uncertainty, although uncertainty is present. For other strategic plans like Structuurvisies, there may be more different objects present in one plan at the same time. In those cases the application of similar visual variables as were used here, will prove helpful.

### **6.3 Recommendations**

Looking at the design limitations following from the OGC specifications, it would be desirable to develop a number of extensions to those specifications. This would offer new possibilities for more complex visualizations, including uncertainty. A first addition would be the ability to apply fuzziness to borders of polygons.

As uncertainty visualization is still a new topic in this field, further research will be needed to be able to implement it in spatial plans. A first step could be to identify the concepts and terms that constitute spatial plans. They define (at least in part) the uncertainty of the plan. It would be interesting to see if a fixed set of terms can be found and projected on some sort of scale. From it, levels of impact and/or uncertainty could be derived. It could be the start of the development of standards as mentioned earlier.

For geographical terms a similar problem remains. How can there be more control and clarity over geographical names that are used, and which locations they refer to? The solution might be quite different. It is possible to create some sort of gazetteer (geographical dictionary) for geographical names. Digital gazetteers already exist. A gazetteer is quite the opposite of a standard. Standards (as intended above) are limited lists, whereas gazetteers contain abundant data. Different people might associate different locations to one specific term. It could be investigated if the use of a gazetteer can be included in the conception of spatial plans, to make sure that policy makers know which interpretations of the geographical names they use exist.



# Glossary

## Dutch terms

Bestemmingsplan - Local zoning plan, formulating binding restrictions on land use and construction

DURP - Digitale uitwisselbare ruimtelijke processen

MJP2 - Agenda voor een Vitaal Platteland, Meerjarenprogramma 2007–2013

Nota op de Ruimtelijke ordening - Strategic national spatial planning policy document

RO Standaarden - Set of standards to which Dutch spatial plans must comply as defined in the Wro and associated regulations.

Streekplan - Provincial spatial plan

Structuurvisie - An indicative spatial plan, either at local or regional scale

Wro - Wet Ruimtelijke Ordening, Spatial planning act (2008)

Zoekzone – Search area, a term often used in strategic spatial plans

## Abbreviations

AJAX - Asynchronous Javascript And XML

API - Application Programming Interface

CGI - Common Gateway Interface

GI - Geo Information

GII - Geo Information Infrastructure (synonym for SDI)

GIS - Geographic Information Systems

GUI - Graphical User Interface

OGC - Open Geospatial Consortium

SDI or GDI - (Geo-) Spatial Data Infrastructure (synonym for GII)

SOA - Service Oriented Architecture

WMS - Web Map Service

WFS - Web Feature Service

## **Bibliography**

- Bertin, J. (1967). *Semiologie Graphique: les diagrammes, les réseaux, les cartes*. Paris, Gauthier-Villars.
- Besemer, J. W. J. (2005). *Belang, Bewustzijn en Betrokkenheid: de Rijksoverheid en de Geo-Informatie Infrastructuur*. Delft, Technische Universiteit. PhD.
- Bishr, M. and W. Kuhn (2007). *Geospatial Information Bottom-Up: A Matter of Trust and Semantics*. The European Information Society: 365-387.
- Boer, A., T. Van Engers, R. Peters and R. Winkels (2007). *Separating law from geography in GIS-based eGovernment services*. *Artif. Intell. Law* 15(1): 49-76.
- Brinkhoff, T. (2007). *Increasing the Fitness of OGC-Compliant Web Map Services for the Web 2.0*. The European Information Society: 247-264.
- De Graaf, P. J. (2006). *Geographic Information Infrastructure and Local Land Use Plans*. GIMA Master Programme. Utrecht, Utrecht University. MSc.
- Dietze, L. and A. Zipf (2007). *Extending OGC Styled Layer Descriptor (SLD) for Thematic Cartography - Towards the ubiquitous use of advanced mapping functions through standardized visualization rules*. 4th International Symposium on LBS and TeleCartography, Hong Kong.
- Drecki, I. (2007). *Information uncertainty: the concept and representational challenges*. XXIII International Cartographic Conference. Moscow, Russia.
- Duckham, M., K. Mason, J. Stell and M. Worboys (2001). *A formal approach to imperfection in geographic information*. *Computers, Environment and Urban Systems* 25: 89-103.
- Dühr, S. (2007). *The Visual Language of Spatial Planning - Exploring Cartographic Representations for Spatial Planning in Europe*. Abingdon, Routledge.
- Fisher, P. F., L. Bastin and J. Wood (2002). *Visualizing uncertainty in multi-spectral remotely sensed imagery*. *Computers & Geosciences* 28(3): 337-350.
- Förster, T. E. M. J., J. E. Stoter & R. L. G. Lemmens (2007). *Towards automatic web-based generalization processing: a case study*. 10th ICA workshop on generalisation and multiple representation. Moscow.
- Förster, T. E. M. J., J. E. Stoter and R. Lemmens (2008). *An interoperable Web Service Architecture to Provide Base Maps Empowered by Automated Generalisation*.

The 13th International Symposium on Spatial Data Handling. Montpellier, International Institute for Geoinformation and Earth Observation.

- Gelderland (2006). Vitaal Gelderland, Provinciaal Meerjarenprogramma 2007 - 2013.
- Geonovum (2008). Informatie Model Ruimtelijke Ordening. M. v. VROM, <http://ro-standaarden.geonovum.nl/images/stories/20081224%20imro2008.pdf>
- Geonovum (2008). Standaard Vergelijkbare Bestemmingsplannen. M. v. VROM, <http://ro-standaarden.geonovum.nl/images/stories/20081224%20svbp2008.pdf>
- GroeneRuimte. (2009). Dossier EHS. 2009, from <http://www.groeneruimte.nl/dossiers/ehs/home.html/>.
- Jiang, B. (1998). Visualization of fuzzy boundaries of geographic objects. Cartography: Journal of Mapping Sciences Institute, Australia 27: 31-36.
- Kraak, M. J. (2004). The role of the map in a Web-GIS environment. Journal of geographical systems 6(2): 83-93.
- Kraak, M. J. and F. Ormeling (2003). Cartography: Visualization of Geospatial Data. Harlow, Pearson Education Limited.
- Leyk, S., R. Boesch and R. Weibel (2005). A Conceptual Framework for Uncertainty Investigation in Map-based Land Cover Change Modelling. Transactions in GIS 9(3): 291-322.
- LNV (2006). Agenda voor een Vitaal Platteland, Meerjarenprogramma 2007 - 2013.
- MacEachren, A. M. (1995). How maps work : representation, visualization and design. New York, The Guildford Press.
- MacEachren, A. M., A. Robinson, S. Hopper, S. Gardner, R. Murray, M. Gahegan and e. al. (2005). Visualizing Geospatial Information Uncertainty: What We Know and What We Need to Know. Cartography and Geographic Information Science 32: 139-160.
- Mommaas, H. and J. Janssen (2008). Towards a synergy between 'content' and 'process' in Dutch spatial planning: the Heuvelland case. Journal of Housing and the Built Environment 23(1): 21-35.
- OGC. (2005). The Importance of Going "Open", An Open Geospatial Consortium (OGC) White Paper. 2008, from [http://portal.opengeospatial.org/files/?artifact\\_id=6211](http://portal.opengeospatial.org/files/?artifact_id=6211).
- Pang, A. (2001). Visualizing Uncertainty in Geo-spatial Data. Workshop on the Intersections between Geospatial Information and Information Technology, Academies Committee of the Computer Science and Telecommunications Board, Washington DC.
- Pang, A., C. M. Wittenbrink and S. K. Lodha (1997). Approaches to uncertainty visualization. The Visual Computer 13: 370-390.
- Sayar, A., M. Pierce and G. Fox (2006). Integrating AJAX Approach into GIS Visualization Web Services. Advanced International Conference on Telecommunications and International Conference on Internet and Web Applications and Services (AICT-ICIW '06). . Guadeloupe, Indiana University.



- Slocum, T. A., R. B. McMaster, F. C. Kessler and H. H. Howard (2009). Thematic Cartography and Geovisualization. Upper Saddle River, NJ, Pearson Prentice Hall.
- Thomson, J., B. Hetzler, A. M. MacEachren, M. Gahegan and M. Pavel (2005). A Typology for Visualizing Uncertainty. Conference on Visualization and Data Analysis 2005. San Jose.
- UN. (2009). United Nations E-Government Readiness Knowledge Base. Retrieved 28 January, 2009, from <http://www2.unpan.org/egovkb/>.
- Van der Cammen, H. and L. De Klerk (2003). Ruimtelijke Ordening - Van Grachtengordel tot Vinexwijk. Utrecht, Het Spectrum.
- Van der Woud, A. (1987). Het lege land - De ruimtelijke orde van Nederland 1798-1848. Amsterdam, Contact.
- Veen, H. t. and F. Bloemhof (2005). Opiniepeiling GeO3 Problematiek. Hoogwoud.
- Voorst. (2009). Digitaal Loket Voorst. Retrieved February 2009, from <https://www.gemgids.nl/voorst/>.
- VROM (2004). Nota Ruimte.
- VROM (2008). Wet ruimtelijke ordening (Wro).
- VROM, VNG and IPO. (2009). Ruimtelijkeplannen.nl. Retrieved june, 2009, from [www.ruimtelijkeplannen.nl](http://www.ruimtelijkeplannen.nl).
- Vullings, L. A. E., C. Blok, G. Vonk, M. v. Heusden, A. Huisman, J. M. v. Linge, S. C. Keijzer, J. Oldengarm and J. D. Bulens (2009). Omgaan met digitale nationale beleidskaarten. Werkdocumenten WOt. Wageningen, Wageningen UR. 141.
- Vullings, W., J. Bulens and A. Ligtenberg (2005). Het vergelijk van de toekomst. Wageningen, Alterra Wageningen UR.
- Vullings, W., M. De Vries and L. De Borman (2007). Dealing with uncertainty in spatial planning. 10th AGILE International Conference on Geographic Information Science. Aalborg University, Denmark.
- W3C. (2009). About the World Wide Web Consortium (W3C). Retrieved March 2009, from <http://www.w3.org/Consortium>.
- WRR (1998). Ruimtelijke Ontwikkelingspolitiek. Rapporten aan de Regering. The Hague, Wetenschappelijke Raad voor het Regeringsbeleid. 53.



## Appendix 1: SLD files

EHS: 00\_ehs\_style.sld

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  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
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## Solid connections: 02\_rob\_verb\_alt\_line\_style.sld

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          <ogc:Filter xmlns:gml="http://www.opengis.net/gml">
            <ogc:PropertyIsEqualTo>
              <ogc:PropertyName>idn</ogc:PropertyName>
              <ogc:Literal>2</ogc:Literal>
            </ogc:PropertyIsEqualTo>
          </ogc:Filter>
          <MinScaleDenominator>650000</MinScaleDenominator>
          <LineSymbolizer>
            <Stroke>
              <CssParameter name="stroke">#ffff</CssParameter>
              <CssParameter name="stroke-opacity">1</CssParameter>
              <CssParameter name="stroke-width">12</CssParameter>

            </Stroke>
          </LineSymbolizer>

```

```

</Rule>

<Rule>
  <ogc:Filter xmlns:gml="http://www.opengis.net/gml">
<ogc:PropertyIsEqualTo>
  <ogc:PropertyName>idn</ogc:PropertyName>
  <ogc:Literal>2</ogc:Literal>
</ogc:PropertyIsEqualTo>
</ogc:Filter>
<MinScaleDenominator>650000</MinScaleDenominator>
<LineSymbolizer>
  <Stroke>
    <CssParameter name="stroke">#660099</CssParameter>
    <CssParameter name="stroke-opacity">1</CssParameter>
    <CssParameter name="stroke-width">6</CssParameter>
  </Stroke>
</LineSymbolizer>
</Rule>

<Rule>
  <ogc:Filter xmlns:gml="http://www.opengis.net/gml">
<ogc:PropertyIsEqualTo>
  <ogc:PropertyName>idn</ogc:PropertyName>
  <ogc:Literal>2</ogc:Literal>
</ogc:PropertyIsEqualTo>
</ogc:Filter>
<MinScaleDenominator>650000</MinScaleDenominator>
<LineSymbolizer>
  <Stroke>
    <CssParameter name="stroke">#FFFFFF</CssParameter>
    <CssParameter name="stroke-opacity">1</CssParameter>
    <CssParameter name="stroke-width">1</CssParameter>
  </Stroke>
</LineSymbolizer>
</Rule>

<Rule>
  <ogc:Filter xmlns:gml="http://www.opengis.net/gml">
<ogc:PropertyIsEqualTo>
  <ogc:PropertyName>idn</ogc:PropertyName>
  <ogc:Literal>1</ogc:Literal>
</ogc:PropertyIsEqualTo>
</ogc:Filter>
<MinScaleDenominator>650000</MinScaleDenominator>
<LineSymbolizer>
  <Stroke>
    <CssParameter name="stroke">#ffff</CssParameter>
    <CssParameter name="stroke-opacity">0.6</CssParameter>
    <CssParameter name="stroke-width">4</CssParameter>
    <CssParameter name="stroke-dasharray">14 4</CssParameter>
  </Stroke>
</LineSymbolizer>
</Rule>

<Rule>
  <ogc:Filter xmlns:gml="http://www.opengis.net/gml">
<ogc:PropertyIsEqualTo>
  <ogc:PropertyName>idn</ogc:PropertyName>
  <ogc:Literal>1</ogc:Literal>
</ogc:PropertyIsEqualTo>
</ogc:Filter>

```

```

<MinScaleDenominator>650000</MinScaleDenominator>
<LineSymbolizer>
  <Stroke>
    <CssParameter name="stroke">#9900FF</CssParameter>
    <CssParameter name="stroke-opacity">1</CssParameter>
    <CssParameter name="stroke-width">2</CssParameter>
    <CssParameter name="stroke-dasharray">0 1 12 5</CssParameter>
  </Stroke>
</LineSymbolizer>
</Rule>

```

```

<!-- ***** -->
<!-- SCALE RANGE Regional 650000 200000 -->
<!-- ***** -->

```

```

<Rule>
  <ogc:Filter xmlns:gml="http://www.opengis.net/gml">
<ogc:PropertyIsEqualTo>
  <ogc:PropertyName>idn</ogc:PropertyName>
  <ogc:Literal>2</ogc:Literal>
</ogc:PropertyIsEqualTo>
</ogc:Filter>
<MinScaleDenominator>200000</MinScaleDenominator>
<MaxScaleDenominator>650000</MaxScaleDenominator>
<LineSymbolizer>
  <Stroke>
    <CssParameter name="stroke">#ffff</CssParameter>
    <CssParameter name="stroke-opacity">0.6</CssParameter>
    <CssParameter name="stroke-width">30</CssParameter>
  </Stroke>
</LineSymbolizer>
</Rule>

```

```

<Rule>
  <ogc:Filter xmlns:gml="http://www.opengis.net/gml">
<ogc:PropertyIsEqualTo>
  <ogc:PropertyName>idn</ogc:PropertyName>
  <ogc:Literal>2</ogc:Literal>
</ogc:PropertyIsEqualTo>
</ogc:Filter>
<MinScaleDenominator>200000</MinScaleDenominator>
<MaxScaleDenominator>650000</MaxScaleDenominator>
<LineSymbolizer>
  <Stroke>
    <CssParameter name="stroke">#660099</CssParameter>
    <CssParameter name="stroke-opacity">0.6</CssParameter>
    <CssParameter name="stroke-width">18</CssParameter>
  </Stroke>
</LineSymbolizer>
</Rule>

```

```

<Rule>
  <ogc:Filter xmlns:gml="http://www.opengis.net/gml">
<ogc:PropertyIsEqualTo>
  <ogc:PropertyName>idn</ogc:PropertyName>
  <ogc:Literal>2</ogc:Literal>
</ogc:PropertyIsEqualTo>
</ogc:Filter>
<MinScaleDenominator>200000</MinScaleDenominator>
<MaxScaleDenominator>650000</MaxScaleDenominator>
<LineSymbolizer>

```



```

<Stroke>
  <CssParameter name="stroke">#FFFFFF</CssParameter>
  <CssParameter name="stroke-opacity">1</CssParameter>
  <CssParameter name="stroke-width">1</CssParameter>
</Stroke>
</LineSymbolizer>
</Rule>

<Rule>
  <ogc:Filter xmlns:gml="http://www.opengis.net/gml">
    <ogc:PropertyIsEqualTo>
      <ogc:PropertyName>idn</ogc:PropertyName>
      <ogc:Literal>1</ogc:Literal>
    </ogc:PropertyIsEqualTo>
  </ogc:Filter>
  <MinScaleDenominator>200000</MinScaleDenominator>
  <MaxScaleDenominator>650000</MaxScaleDenominator>
  <LineSymbolizer>
    <Stroke>
      <CssParameter name="stroke">#ffff</CssParameter>
      <CssParameter name="stroke-opacity">0.8</CssParameter>
      <CssParameter name="stroke-width">6</CssParameter>
      <CssParameter name="stroke-dasharray">20 4</CssParameter>
    </Stroke>
  </LineSymbolizer>
</Rule>

<Rule>
  <ogc:Filter xmlns:gml="http://www.opengis.net/gml">
    <ogc:PropertyIsEqualTo>
      <ogc:PropertyName>idn</ogc:PropertyName>
      <ogc:Literal>1</ogc:Literal>
    </ogc:PropertyIsEqualTo>
  </ogc:Filter>
  <MinScaleDenominator>200000</MinScaleDenominator>
  <MaxScaleDenominator>650000</MaxScaleDenominator>
  <LineSymbolizer>
    <Stroke>
      <CssParameter name="stroke">#9900FF</CssParameter>
      <CssParameter name="stroke-opacity">1</CssParameter>
      <CssParameter name="stroke-width">2</CssParameter>
      <CssParameter name="stroke-dasharray">0 2 16 6</CssParameter>
    </Stroke>
  </LineSymbolizer>
</Rule>

<!-- ***** -->
<!-- SCALE RANGE Local Max 200000 -->
<!-- ***** -->

<Rule>
  <ogc:Filter xmlns:gml="http://www.opengis.net/gml">
    <ogc:PropertyIsEqualTo>
      <ogc:PropertyName>idn</ogc:PropertyName>
      <ogc:Literal>2</ogc:Literal>
    </ogc:PropertyIsEqualTo>
  </ogc:Filter>
  <MaxScaleDenominator>200000</MaxScaleDenominator>
  <LineSymbolizer>
    <Stroke>
      <CssParameter name="stroke">#ffff</CssParameter>

```

```

    <CssParameter name="stroke-opacity">0.6</CssParameter>
    <CssParameter name="stroke-width">64</CssParameter>
  </Stroke>
</LineSymbolizer>
</Rule>

<Rule>
  <ogc:Filter xmlns:gml="http://www.opengis.net/gml">
<ogc:PropertyIsEqualTo>
  <ogc:PropertyName>idn</ogc:PropertyName>
  <ogc:Literal>2</ogc:Literal>
</ogc:PropertyIsEqualTo>
</ogc:Filter>
<MaxScaleDenominator>200000</MaxScaleDenominator>
  <LineSymbolizer>
    <Stroke>
      <CssParameter name="stroke">#660099</CssParameter>
      <CssParameter name="stroke-opacity">0.6</CssParameter>
      <CssParameter name="stroke-width">40</CssParameter>
    </Stroke>
  </LineSymbolizer>
</Rule>

<Rule>
  <ogc:Filter xmlns:gml="http://www.opengis.net/gml">
<ogc:PropertyIsEqualTo>
  <ogc:PropertyName>idn</ogc:PropertyName>
  <ogc:Literal>2</ogc:Literal>
</ogc:PropertyIsEqualTo>
</ogc:Filter>
<MaxScaleDenominator>200000</MaxScaleDenominator>
  <LineSymbolizer>
    <Stroke>
      <CssParameter name="stroke">#FFFFFF</CssParameter>
      <CssParameter name="stroke-opacity">1</CssParameter>
      <CssParameter name="stroke-width">2</CssParameter>
    </Stroke>
  </LineSymbolizer>
</Rule>

<Rule>
  <ogc:Filter xmlns:gml="http://www.opengis.net/gml">
<ogc:PropertyIsEqualTo>
  <ogc:PropertyName>idn</ogc:PropertyName>
  <ogc:Literal>1</ogc:Literal>
</ogc:PropertyIsEqualTo>
</ogc:Filter>
<MaxScaleDenominator>200000</MaxScaleDenominator>
  <LineSymbolizer>
    <Stroke>
      <CssParameter name="stroke">#ffff</CssParameter>
      <CssParameter name="stroke-opacity">0.6</CssParameter>
      <CssParameter name="stroke-width">16</CssParameter>
      <CssParameter name="stroke-dasharray">44 10</CssParameter>
    </Stroke>
  </LineSymbolizer>
</Rule>

<Rule>
  <ogc:Filter xmlns:gml="http://www.opengis.net/gml">
<ogc:PropertyIsEqualTo>

```

```

    <ogc:PropertyName>idn</ogc:PropertyName>
    <ogc:Literal>1</ogc:Literal>
  </ogc:PropertyIsEqualTo>
</ogc:Filter>
<MaxScaleDenominator>200000</MaxScaleDenominator>
  <LineStyleSymbolizer>
    <Stroke>
      <CssParameter name="stroke">#9900FF</CssParameter>
      <CssParameter name="stroke-opacity">0.6</CssParameter>
      <CssParameter name="stroke-width">8</CssParameter>
      <CssParameter name="stroke-dasharray">0 4 36 14</CssParameter>
    </Stroke>
  </LineStyleSymbolizer>
</Rule>

</FeatureTypeStyle>
</UserStyle>
</NamedLayer>
</StyledLayerDescriptor>

```

## National Landscapes: 13\_nat\_landschappen\_style.sld

```

<?xml version="1.0" encoding="UTF-8"?>
<StyledLayerDescriptor version="1.0.0"
  xsi:schemaLocation="http://www.opengis.net/sld StyledLayerDescriptor.xsd"
  xmlns="http://www.opengis.net/sld" xmlns:ogc="http://www.opengis.net/ogc"
  xmlns:xlink="http://www.w3.org/1999/xlink"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
  <NamedLayer>
    <Name>13_nat_landschappen</Name>
    <UserStyle>
      <Name>13_nat_landschappen_style</Name>
      <Title>geoserver style</Title>
      <Abstract>Generated by GeoServer</Abstract>
      <FeatureTypeStyle>

        <!-- ***** -->
        <!-- SCALE RANGE National Min 650000 -->
        <!-- ***** -->
        <!-- NADER TE BEPALEN, NR 1, schaal nationaal-->

        <Rule>
          <ogc:Filter xmlns:gml="http://www.opengis.net/gml">
            <ogc:PropertyIsEqualTo>
              <ogc:PropertyName>TYPE</ogc:PropertyName>
              <ogc:Literal>nader te begrenzen</ogc:Literal>
            </ogc:PropertyIsEqualTo>
          </ogc:Filter>
          <MinScaleDenominator>650000</MinScaleDenominator>

          <PolygonSymbolizer>
            <Fill>
              <CssParameter name="fill">#009900</CssParameter>
              <CssParameter name="fill-opacity">0.2</CssParameter>

```

```

        </Fill>
        <Stroke>
          <CssParameter name="stroke">#009900</CssParameter>
        <CssParameter name="stroke-opacity">0.2</CssParameter>
        <CssParameter name="stroke-width">20</CssParameter>
        </Stroke>
      </PolygonSymbolizer>
    </Rule>

    <!-- NADER TE BEPALEN, NR 2, schaal nationaal -->

    <Rule>
    <ogc:Filter xmlns:gml="http://www.opengis.net/gml">
    <ogc:PropertyIsEqualTo>
      <ogc:PropertyName>TYPE</ogc:PropertyName>
      <ogc:Literal>nader te begrenzen</ogc:Literal>
    </ogc:PropertyIsEqualTo>
    </ogc:Filter>
      <MinScaleDenominator>65000</MinScaleDenominator>
      <PolygonSymbolizer>
        <Fill>
          <CssParameter name="fill">#009900</CssParameter>
          <CssParameter name="fill-opacity">0.4</CssParameter>
        </Fill>
        <Stroke>
          <CssParameter name="stroke">#009900</CssParameter>
        <CssParameter name="stroke-opacity">0.4</CssParameter>
        <CssParameter name="stroke-width">10</CssParameter>
        </Stroke>
      </PolygonSymbolizer>
    </Rule>

    <!-- NADER TE BEPALEN, NR 3, schaal nationaal -->

    <Rule>
    <ogc:Filter xmlns:gml="http://www.opengis.net/gml">
    <ogc:PropertyIsEqualTo>
      <ogc:PropertyName>TYPE</ogc:PropertyName>
      <ogc:Literal>nader te begrenzen</ogc:Literal>
    </ogc:PropertyIsEqualTo>
    </ogc:Filter>
      <MinScaleDenominator>65000</MinScaleDenominator>
      <PolygonSymbolizer>
        <Fill>
          <CssParameter name="fill">#009900</CssParameter>
          <CssParameter name="fill-opacity">0.8</CssParameter>
        </Fill>
        <Stroke>
          <CssParameter name="stroke">#000000</CssParameter>
        <CssParameter name="stroke-opacity">0</CssParameter>
        <CssParameter name="stroke-width">2</CssParameter>
        </Stroke>
      </PolygonSymbolizer>
      <TextSymbolizer>
        <Label>
          <ogc:PropertyName>NAAM</ogc:PropertyName>
        </Label>
        <Font>
          <CssParameter name="font-family">Arial</CssParameter>
          <CssParameter name="font-style">Normal</CssParameter>

```

```

        <CssParameter name="font-size">10</CssParameter>
      </Font>
      <Halo/>
    <Fill>
      <CssParameter name="fill">#000000</CssParameter>
      <CssParameter name="fill-opacity">1</CssParameter>
    </Fill>
  </TextSymbolizer>
</Rule>

<!-- NADER TE BEPALEN, GRAPHICSTROKE, kleine schaal -->

<!-- <Rule>
<ogc:Filter xmlns:gml="http://www.opengis.net/gml">
  <ogc:PropertyIsEqualTo>
    <ogc:PropertyName>TYPE</ogc:PropertyName>
    <ogc:Literal>nader te begrenzen</ogc:Literal>
  </ogc:PropertyIsEqualTo>
</ogc:Filter>
  <MinScaleDenominator>65000</MinScaleDenominator>

  <PolygonSymbolizer>
    <Fill>
      <CssParameter name="fill">#009900</CssParameter>
      <CssParameter name="fill-opacity">0.4</CssParameter>
    </Fill>
    <Stroke>
<GraphicStroke>
  <Graphic>
    <ExternalGraphic>
      <OnlineResource xlink:href="http://www.stevenkeijzer.nl/gima/images/streep.gif"/>
      <Format>image/gif</Format>
    </ExternalGraphic>

    <Size>32</Size>
  </Graphic>
</GraphicStroke>

  <CssParameter name="stroke-opacity">1</CssParameter>
  <CssParameter name="stroke-width">15</CssParameter>
</Stroke>
</PolygonSymbolizer>

<TextSymbolizer>
  <Label>
    <ogc:PropertyName>NAAM</ogc:PropertyName>
  </Label>
  <Font>
    <CssParameter name="font-family">Arial</CssParameter>
    <CssParameter name="font-style">Normal</CssParameter>
    <CssParameter name="font-size">10</CssParameter>
  </Font>
  <Halo/>
<Fill>
  <CssParameter name="fill">#000000</CssParameter>
  <CssParameter name="fill-opacity">0.8</CssParameter>
</Fill>
</TextSymbolizer>
</Rule> -->

<!-- ***** -->

```

```

<!-- SCALE RANGE Regional 650000 200000 -->
<!-- ***** -->
<!-- NADER TE BEPALEN, NR 1, schaal midden -->

<Rule>
<ogc:Filter xmlns:gml="http://www.opengis.net/gml">
<ogc:PropertyIsEqualTo>
<ogc:PropertyName>TYPE</ogc:PropertyName>
<ogc:Literal>nader te begrenzen</ogc:Literal>
</ogc:PropertyIsEqualTo>
</ogc:Filter>
<MinScaleDenominator>200000</MinScaleDenominator>
<MaxScaleDenominator>650000</MaxScaleDenominator>

<PolygonSymbolizer>
<Fill>
<CssParameter name="fill">#009900</CssParameter>
<CssParameter name="fill-opacity">0.2</CssParameter>
</Fill>
<Stroke>
<CssParameter name="stroke">#009900</CssParameter>
<CssParameter name="stroke-opacity">0.2</CssParameter>
<CssParameter name="stroke-width">40</CssParameter>
</Stroke>
</PolygonSymbolizer>
</Rule>

<!-- NADER TE BEPALEN, NR 2, schaal midden -->

<Rule>
<ogc:Filter xmlns:gml="http://www.opengis.net/gml">
<ogc:PropertyIsEqualTo>
<ogc:PropertyName>TYPE</ogc:PropertyName>
<ogc:Literal>nader te begrenzen</ogc:Literal>
</ogc:PropertyIsEqualTo>
</ogc:Filter>
<MinScaleDenominator>200000</MinScaleDenominator>
<MaxScaleDenominator>650000</MaxScaleDenominator>
<PolygonSymbolizer>
<Fill>
<CssParameter name="fill">#009900</CssParameter>
<CssParameter name="fill-opacity">0.4</CssParameter>
</Fill>
<Stroke>
<CssParameter name="stroke">#009900</CssParameter>
<CssParameter name="stroke-opacity">0.4</CssParameter>
<CssParameter name="stroke-width">20</CssParameter>
</Stroke>
</PolygonSymbolizer>
</Rule>

<!-- NADER TE BEPALEN, NR 3, schaal midden -->

<Rule>
<ogc:Filter xmlns:gml="http://www.opengis.net/gml">
<ogc:PropertyIsEqualTo>
<ogc:PropertyName>TYPE</ogc:PropertyName>
<ogc:Literal>nader te begrenzen</ogc:Literal>
</ogc:PropertyIsEqualTo>
</ogc:Filter>
<MinScaleDenominator>200000</MinScaleDenominator>

```

```

<MaxScaleDenominator>650000</MaxScaleDenominator>
  <PolygonSymbolizer>
    <Fill>
      <CssParameter name="fill">#009900</CssParameter>
      <CssParameter name="fill-opacity">0.8</CssParameter>
    </Fill>
    <Stroke>
      <CssParameter name="stroke">#000000</CssParameter>
      <CssParameter name="stroke-opacity">0</CssParameter>
      <CssParameter name="stroke-width">2</CssParameter>
    </Stroke>
  </PolygonSymbolizer>
  <TextSymbolizer>
    <Label>
      <ogc:PropertyName>NAAM</ogc:PropertyName>
    </Label>
    <Font>
      <CssParameter name="font-family">Arial</CssParameter>
      <CssParameter name="font-style">Normal</CssParameter>
      <CssParameter name="font-size">10</CssParameter>
    </Font>
    <Halo/>
  </TextSymbolizer>
</Fill>
  <CssParameter name="fill">#000000</CssParameter>
  <CssParameter name="fill-opacity">1</CssParameter>
</Fill>
</TextSymbolizer>
</Rule>

<!-- ***** -->
<!-- SCALE RANGE Local Max 200000 -->
<!-- ***** -->
<!-- NADER TE BEPALEN, NR 1, schaal lokaal -->

<Rule>
<ogc:Filter xmlns:gml="http://www.opengis.net/gml">
  <ogc:PropertyIsEqualTo>
    <ogc:PropertyName>TYPE</ogc:PropertyName>
    <ogc:Literal>nader te begrenzen</ogc:Literal>
  </ogc:PropertyIsEqualTo>
</ogc:Filter>
<MaxScaleDenominator>200000</MaxScaleDenominator>

  <PolygonSymbolizer>
    <Fill>
      <CssParameter name="fill">#009900</CssParameter>
      <CssParameter name="fill-opacity">0.2</CssParameter>
    </Fill>
    <Stroke>
      <CssParameter name="stroke">#009900</CssParameter>
      <CssParameter name="stroke-opacity">0.2</CssParameter>
      <CssParameter name="stroke-width">100</CssParameter>
    </Stroke>
  </PolygonSymbolizer>
</Rule>

<!-- NADER TE BEPALEN, NR 2, schaal lokaal -->

<Rule>
<ogc:Filter xmlns:gml="http://www.opengis.net/gml">

```

```

<ogc:PropertyIsEqualTo>
  <ogc:PropertyName>TYPE</ogc:PropertyName>
  <ogc:Literal>nader te begrenzen</ogc:Literal>
</ogc:PropertyIsEqualTo>
</ogc:Filter>
<MaxScaleDenominator>200000</MaxScaleDenominator>
  <PolygonSymbolizer>
    <Fill>
      <CssParameter name="fill">#009900</CssParameter>
      <CssParameter name="fill-opacity">0.4</CssParameter>
    </Fill>
    <Stroke>
      <CssParameter name="stroke">#009900</CssParameter>
      <CssParameter name="stroke-opacity">0.4</CssParameter>
      <CssParameter name="stroke-width">50</CssParameter>
    </Stroke>
  </PolygonSymbolizer>
</Rule>

<!-- NADER TE BEPALEN, NR 3, schaal lokaal -->

<Rule>
<ogc:Filter xmlns:gml="http://www.opengis.net/gml">
  <ogc:PropertyIsEqualTo>
    <ogc:PropertyName>TYPE</ogc:PropertyName>
    <ogc:Literal>nader te begrenzen</ogc:Literal>
  </ogc:PropertyIsEqualTo>
</ogc:Filter>
<MaxScaleDenominator>200000</MaxScaleDenominator>
  <PolygonSymbolizer>
    <Fill>
      <CssParameter name="fill">#009900</CssParameter>
      <CssParameter name="fill-opacity">0.8</CssParameter>
    </Fill>
    <Stroke>
      <CssParameter name="stroke">#000000</CssParameter>
      <CssParameter name="stroke-opacity">0</CssParameter>
      <CssParameter name="stroke-width">2</CssParameter>
    </Stroke>
  </PolygonSymbolizer>
  <TextSymbolizer>
    <Label>
      <ogc:PropertyName>NAAM</ogc:PropertyName>
    </Label>
    <Font>
      <CssParameter name="font-family">Arial</CssParameter>
      <CssParameter name="font-style">Normal</CssParameter>
      <CssParameter name="font-size">10</CssParameter>
    </Font>
    <Halo/>
  </TextSymbolizer>
  <Fill>
    <CssParameter name="fill">#000000</CssParameter>
    <CssParameter name="fill-opacity">1</CssParameter>
  </Fill>
</TextSymbolizer>
</Rule>

<!-- GROENE HART, alle schalen -->

<Rule>

```



```

<ogc:Filter xmlns:gml="http://www.opengis.net/gml">

  <ogc:PropertyIsEqualTo>
    <ogc:PropertyName>NAAM</ogc:PropertyName>
    <ogc:Literal>Groene hart</ogc:Literal>
  </ogc:PropertyIsEqualTo>

</ogc:Filter>

<PolygonSymbolizer>
  <Fill>
    <CssParameter name="fill">#66cc00</CssParameter>
    <CssParameter name="fill-opacity">0.8</CssParameter>
  </Fill>
  <Stroke>
    <CssParameter name="stroke">#003300</CssParameter>
    <CssParameter name="stroke-opacity">1</CssParameter>
    <CssParameter name="stroke-width">1</CssParameter>
    <CssParameter name="PerpendicularOffset">20000</CssParameter>
  </Stroke>
</PolygonSymbolizer>
<TextSymbolizer>
  <Label>
    <ogc:PropertyName>NAAM</ogc:PropertyName>
  </Label>
  <Font>
    <CssParameter name="font-family">Arial</CssParameter>
    <CssParameter name="font-style">Normal</CssParameter>
    <CssParameter name="font-size">10</CssParameter>
  </Font>
  <Halo/>
<Fill>
  <CssParameter name="fill">#003300</CssParameter>
  <CssParameter name="fill-opacity">1</CssParameter>
</Fill>
</TextSymbolizer>
</Rule>

<!-- Nieuwe Hollandse Waterlinie, alle schalen -->

<Rule>
<ogc:Filter xmlns:gml="http://www.opengis.net/gml">

  <ogc:PropertyIsEqualTo>
    <ogc:PropertyName>NAAM</ogc:PropertyName>
    <ogc:Literal>Nieuwe Hollandse Waterlinie</ogc:Literal>
  </ogc:PropertyIsEqualTo>

</ogc:Filter>

  <PolygonSymbolizer>
    <Fill>
      <CssParameter name="fill">#669900</CssParameter>
      <CssParameter name="fill-opacity">0.8</CssParameter>
    </Fill>
    <Stroke>
      <CssParameter name="stroke">#003300</CssParameter>
      <CssParameter name="stroke-opacity">1</CssParameter>
      <CssParameter name="stroke-width">1</CssParameter>
      <CssParameter name="PerpendicularOffset">20000</CssParameter>
    </Stroke>
  </PolygonSymbolizer>
</Rule>

```

```

</Stroke>
</PolygonSymbolizer>
<TextSymbolizer>
  <Label>
    <ogc:PropertyName>NAAM</ogc:PropertyName>
  </Label>
  <Font>
    <CssParameter name="font-family">Arial</CssParameter>
    <CssParameter name="font-style">Normal</CssParameter>
    <CssParameter name="font-size">10</CssParameter>
  </Font>
  <Halo/>
<Fill>
  <CssParameter name="fill">#003300</CssParameter>
  <CssParameter name="fill-opacity">1</CssParameter>
</Fill>
</TextSymbolizer>
</Rule>

<!-- STELLING VAN AMSTERDAM, alle schalen -->

<Rule>
  <ogc:Filter xmlns:gml="http://www.opengis.net/gml">

    <ogc:PropertyIsEqualTo>
      <ogc:PropertyName>NAAM</ogc:PropertyName>
      <ogc:Literal>Stelling van Amsterdam</ogc:Literal>
    </ogc:PropertyIsEqualTo>

  </ogc:Filter>

  <PolygonSymbolizer>
    <Fill>
      <CssParameter name="fill">#77aa00</CssParameter>
      <CssParameter name="fill-opacity">0.8</CssParameter>
    </Fill>
    <Stroke>
      <CssParameter name="stroke">#003300</CssParameter>
      <CssParameter name="stroke-opacity">1</CssParameter>
      <CssParameter name="stroke-width">1</CssParameter>
      <CssParameter name="PerpendicularOffset">20000</CssParameter>
    </Stroke>
  </PolygonSymbolizer>
<TextSymbolizer>
  <Label>
    <ogc:PropertyName>NAAM</ogc:PropertyName>
  </Label>
  <Font>
    <CssParameter name="font-family">Arial</CssParameter>
    <CssParameter name="font-style">Normal</CssParameter>
    <CssParameter name="font-size">10</CssParameter>
  </Font>
  <Halo/>
<Fill>
  <CssParameter name="fill">#003300</CssParameter>
  <CssParameter name="fill-opacity">1</CssParameter>
</Fill>
</TextSymbolizer>
</Rule>

```

```

    </FeatureTypeStyle>
  </UserStyle>
</NamedLayer>
</StyledLayerDescriptor>

```

## Greenports: 15\_greenports\_style.sld

```

<?xml version="1.0" encoding="UTF-8"?>
<StyledLayerDescriptor version="1.0.0"
  xsi:schemaLocation="http://www.opengis.net/sld StyledLayerDescriptor.xsd"
  xmlns="http://www.opengis.net/sld" xmlns:ogc="http://www.opengis.net/ogc"
  xmlns:xlink="http://www.w3.org/1999/xlink"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
  <NamedLayer>
    <Name>15_greenports</Name>
    <UserStyle>
      <Name>15_greenports_style</Name>
      <Title>geoserver style</Title>
      <Abstract>Generated by GeoServer</Abstract>
      <FeatureTypeStyle>

        <!-- SQUARE -->
        <!-- <Rule>
        <PointSymbolizer>
          <Graphic>
            <Mark>
              <WellKnownName>square</WellKnownName>
              <Fill>
                <CssParameter name="fill">#006600</CssParameter>
                <CssParameter name="fill-opacity">0.4</CssParameter>
              </Fill>
              <Stroke>
                <CssParameter name="stroke">#00ff00</CssParameter>
                <CssParameter name="stroke-width">2</CssParameter>
              </Stroke>
            </Mark>
            <Size>48</Size>
          </Graphic>
        </PointSymbolizer>
        </Rule> -->
        <!-- ***** -->
        <!-- SCALE RANGE National Min 650000 -->
        <!-- ***** -->

        <Rule>
          <MinScaleDenominator>650000</MinScaleDenominator>

        <PointSymbolizer>
          <Graphic>
            <Mark>
              <WellKnownName>square</WellKnownName>
              <Fill>
                <CssParameter name="fill">#00cc00</CssParameter>
                <CssParameter name="fill-opacity">0.2</CssParameter>

```

```

</Fill>
<Stroke>
  <CssParameter name="stroke">#00ff00</CssParameter>
  <CssParameter name="stroke-width">0</CssParameter>
</Stroke>
</Mark>
<Size>42</Size>
</Graphic>
</PointSymbolizer>
  </Rule>

  <Rule>
    <MinScaleDenominator>650000</MinScaleDenominator>

    <PointSymbolizer>
<Graphic>
  <ExternalGraphic>
    <OnlineResource
      xlink:type="simple"
      xlink:href="http://www.stevenkeijzer.nl/gima/images/gp001.png" />
    <Format>image/png</Format>
  </ExternalGraphic>
  <Opacity>1</Opacity>
  <Size>30</Size>
  </Graphic>
  </PointSymbolizer>
  </Rule>
<!-- ***** -->
<!-- SCALE RANGE Regional 650000 200000 -->
<!-- ***** -->
  <Rule>
    <MinScaleDenominator>200000</MinScaleDenominator>
  <MaxScaleDenominator>650000</MaxScaleDenominator>

  <PointSymbolizer>
  <Graphic>
  <Mark>
    <WellKnownName>square</WellKnownName>
    <Fill>
      <CssParameter name="fill">#00cc00</CssParameter>
      <CssParameter name="fill-opacity">0.2</CssParameter>
    </Fill>

    <Stroke>
      <CssParameter name="stroke">#00ff00</CssParameter>
      <CssParameter name="stroke-width">0</CssParameter>
    </Stroke>
  </Mark>
  <Size>72</Size>
  </Graphic>
  </PointSymbolizer>

  </Rule>

  <Rule>
    <MinScaleDenominator>200000</MinScaleDenominator>
  <MaxScaleDenominator>650000</MaxScaleDenominator>

  <PointSymbolizer>
  <Graphic>
    <ExternalGraphic>

```

```

<OnlineResource
  xlink:type="simple"
  xlink:href="http://www.stevenkeijzer.nl/gima/images/gp002.png" />
<Format>image/png</Format>
</ExternalGraphic>
<Opacity>1</Opacity>
<Size>60</Size>
  </Graphic>
  </PointSymbolizer>
</Rule>

<!-- ***** -->
<!-- SCALE RANGE Local Max 200000 -->
<!-- ***** -->

<Rule>
<MaxScaleDenominator>200000</MaxScaleDenominator>

<PointSymbolizer>
  <Graphic>
    <Mark>
      <WellKnownName>square</WellKnownName>
      <Fill>
        <CssParameter name="fill">#00cc00</CssParameter>
        <CssParameter name="fill-opacity">0.2</CssParameter>
      </Fill>

      <Stroke>
        <CssParameter name="stroke">#00ff00</CssParameter>
        <CssParameter name="stroke-width">0</CssParameter>
      </Stroke>
    </Mark>
    <Size>150</Size>
  </Graphic>
</PointSymbolizer>

  </Rule>

  <Rule>
    <MaxScaleDenominator>200000</MaxScaleDenominator>
    <PointSymbolizer>
      <Graphic>
        <ExternalGraphic>
          <OnlineResource
            xlink:type="simple"
            xlink:href="http://www.stevenkeijzer.nl/gima/images/gp003.png" />
          <Format>image/png</Format>
        </ExternalGraphic>
        <Opacity>1</Opacity>
        <Size>120</Size>
        </Graphic>
      </PointSymbolizer>
    </Rule>

  </FeatureTypeStyle>
</UserStyle>
</NamedLayer>
</StyledLayerDescriptor>

```

## Appendix 2: HTML for the web page including the Open Layers script

```
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN"
"http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd">
<html xmlns="http://www.w3.org/1999/xhtml" xml:lang="en" lang="en">
<head>
  <meta http-equiv="Content-Type" content="text/html; charset=UTF-8" />
  <title>GIMA | M8</title>
  <link rel="stylesheet" href="css/blueprint/screen.css" type="text/css" media="screen, projection" />
  <link rel="stylesheet" href="css/blueprint/print.css" type="text/css" media="print" />
  <!--[if IE]>
    <link rel="stylesheet" href="css/blueprint/ie.css" type="text/css" media="screen, projection" />
  <![endif]-->
  <link rel="shortcut icon" type="image/x-icon" href="favicon.ico" />
  <meta http-equiv="imagetoolbar" content="no" />
  <meta http-equiv="Page-Enter" content="blendTrans(Duration=1)" />
  <meta http-equiv="Page-Exit" content="blendTrans(Duration=1)" />

  <!-- SLIMBOX -->
  <script type="text/javascript" src="http://www.stevenkeijzer.nl/slimbox/js/mootools-release-1.11.js"></script>
  <script type="text/javascript" src="http://www.stevenkeijzer.nl/slimbox/js/slimbox.js"></script>

  <!-- GOOGLE -->
  <script src="http://maps.google.com/maps?file=api&v=2&key=ABQIAAAAVelxbTujHFmhfNW17-
  TSgxTX80YGPFxr9LezkL_3av4jksAIXBSH5FpqjWwX6h30i80uN_R2w2s-g"
  type="text/javascript"></script>

  <!-- OPENLAYERS -->
  <script src="http://www.openlayers.org/api/2.4/OpenLayers.js" type="text/javascript"></script>

</head>

<body onload="init()" >
<div class="container buiten showgrid">
<div class="container binnen ">
  <div class="column span-24 first last kop">
  </div>
  <div class="column span-23 append-1 ">
<ul id="navigatie">
  <li><a href="index.php" title="home">home</a>
  </li>
</ul>
  <div class="column span-24 first last strip">
  </div>
  <div class="column span-13 first">
```

```

<div id="map" >
<script type="text/javascript">

var map, google, googles, googleh, googlep, ehs, ehsrv, natlan, greenports, topo;

function init(){

    map = new OpenLayers.Map( 'map', {

        controls: [

            new OpenLayers.Control.PanZoomBar(),
            new OpenLayers.Control.MouseDefaults(),
            new OpenLayers.Control.LayerSwitcher({'ascending':false}),
            new
OpenLayers.Control.MousePosition({'displayProjection':OpenLayers.Projection}),
            new OpenLayers.Control.Permalink(),
            new OpenLayers.Control.Scale(),
            new OpenLayers.Control.KeyboardDefaults({'slideFactor':100})

        ],
        numZoomLevels: 20
    });

    google = new OpenLayers.Layer.Google("Google", {"sphericalMercator": true});
    googles = new OpenLayers.Layer.Google("Google Satellite", { 'type': G_SATELLITE_MAP });
    googleh = new OpenLayers.Layer.Google("Google Hybrid", { 'type': G_HYBRID_MAP });
    googlep = new OpenLayers.Layer.Google("Google Physical", { 'type': G_PHYSICAL_MAP });

natlan = new OpenLayers.Layer.WMS("Nationale Landschappen",
"http://casagrande.geo.tudelft.nl:8088/geoserver/wms?",
    {
        layers: 'mjp:13_nat_landschappen',
        styles: "",
        format: 'image/png',
        tiled: 'true',
        transparent: true
    },
    {
        'isBaseLayer': false, 'wrapDateLine': true
    }
);

greenports = new OpenLayers.Layer.WMS("Greenports, Glastuinbouw",
"http://casagrande.geo.tudelft.nl:8088/geoserver/wms?",
    {
        layers: 'mjp:15_alt',
        styles: "",
        format: 'image/png',
        tiled: 'true',
        transparent: true
    },
    {
        'isBaseLayer': false, 'wrapDateLine': true
    }
);

    ehs = new OpenLayers.Layer.WMS("EHS",
"http://casagrande.geo.tudelft.nl:8088/geoserver/wms?",
    {
        layers: 'mjp:00_ehs',
        styles: "",
        srs: 'EPSG:900913',

```

```

        format: 'image/png',
        tiled: 'true',
        transparent: true
    },
    {
        'isBaseLayer': false, 'wrapDateLine': true
    }
    );

        ehsrv = new OpenLayers.Layer.WMS("EHS, Robuuste Verbinding",
"http://casagrande.geo.tudelft.nl:8088/geoserver/wms?",
    {
        layers: 'mjp:02_rob_verb_alt_line',
        styles: "",
        format: 'image/png',
        tiled: 'true',
        transparent: true
    },
    {
        'isBaseLayer': false, 'wrapDateLine': true
    }
    );

        natlan.setVisibility(false);
        greenports.setVisibility(false);

        map.addLayers([googlep, googleh, googles, natlan, greenports, ehs, ehsrv ]);
        map.setCenter(new OpenLayers.LonLat(4.663, 52.07), 10);
        map.events.register("click", map, function(e) {
            markers.addMarker(new OpenLayers.Marker(this.getLonLatFromPixel(e.xy)));
        });
    }
</script>
</div>
</div>
<div class="column span-12 last survey" >

<!-- SURVEY -->
<IFRAME SRC="http://www.surveymonkey.com/s/2P53MWS" height="100%" width="100%" frameborder="0">
</IFRAME>
</div>
<hr>
        <div class="column span-25 first last ">
            <div class="column span-4 append-9 first ">
<a href="images/legenda.jpg" rel="lightbox[set]" title="Legenda bij de viewer"></a>
            </div>
            <div class="column span-12 last">

<a href="images/krt03.jpg" rel="lightbox[set]" title="EHS, afbeelding van oorspronkelijke kaart, (c) Ministerie van
Lanbouw, Natuur en Voedselkwaliteit 2006"></a>
<a href="images/krt10.jpg" rel="lightbox[set]" title="Greenports, afbeelding van oorspronkelijke kaart, (c)
Ministerie van Lanbouw, Natuur en Voedselkwaliteit 2006"></a>
<a href="images/krt15.jpg" rel="lightbox[set]" title="Nationale Landschappen, afbeelding van oorspronkelijke
kaart, (c) Ministerie van Lanbouw, Natuur en Voedselkwaliteit 2006"></a>
</div></div><div class="column span-23 footer append-1 prepend-1 last"> </div></div></div>
</body>
</html>

```

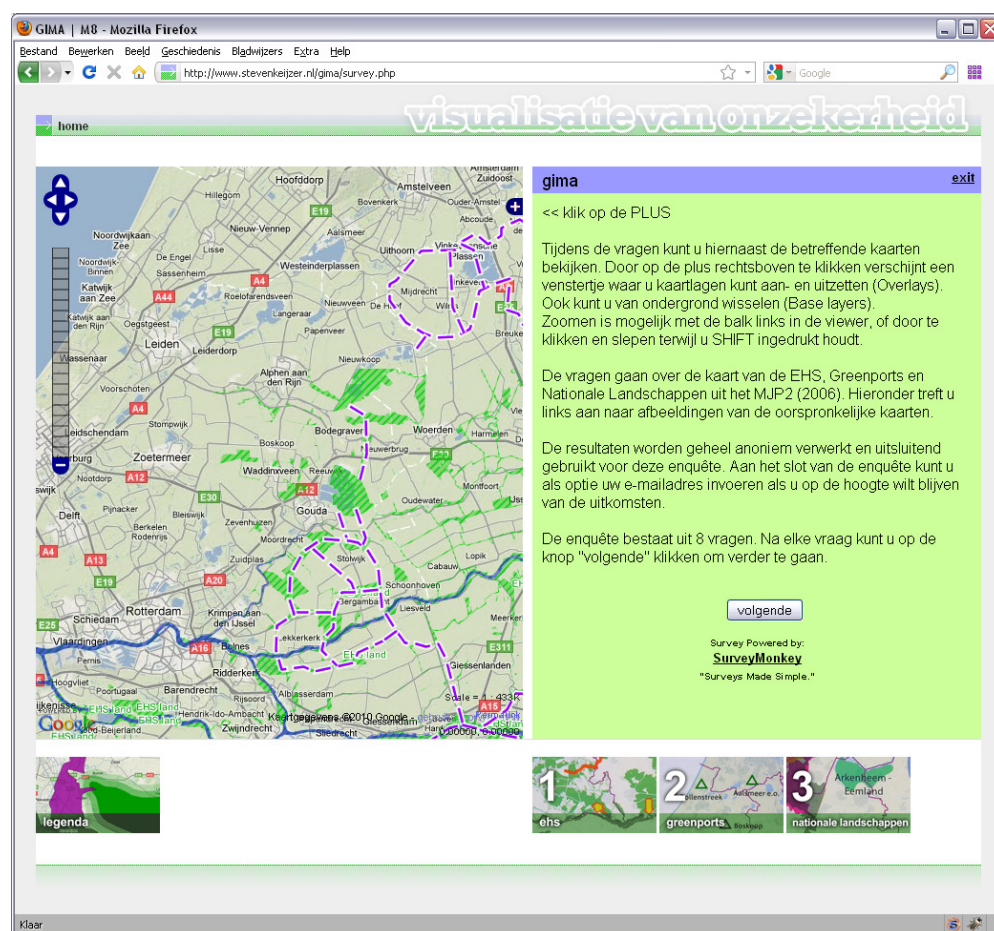


## Appendix 3: images from the survey

Images retrieved from:

<http://geoserver.itc.nl/keijzer>

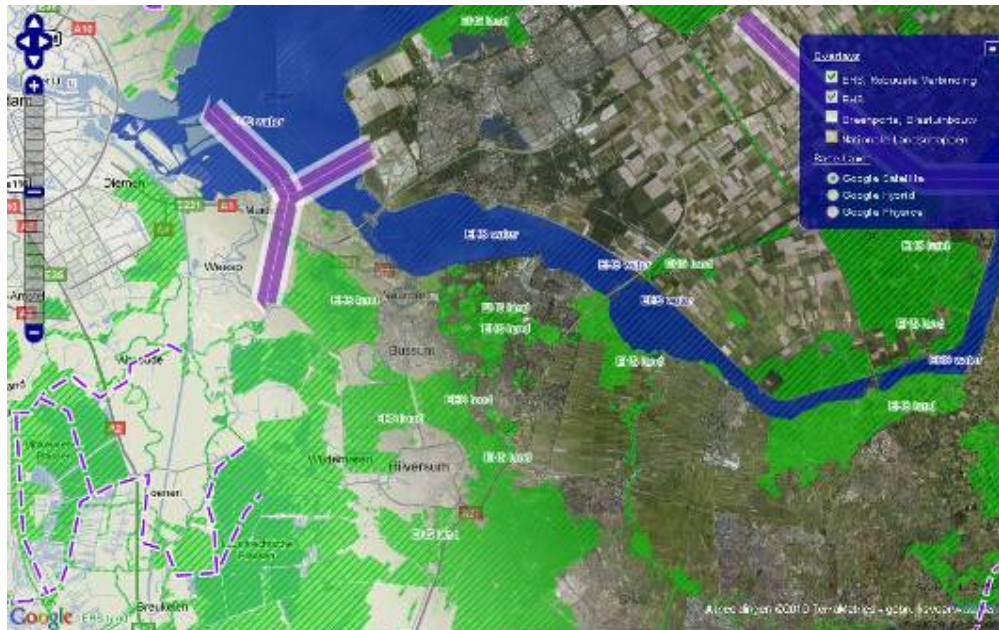
<http://www.stevenkeijzer.nl/gima>



Main page of the survey



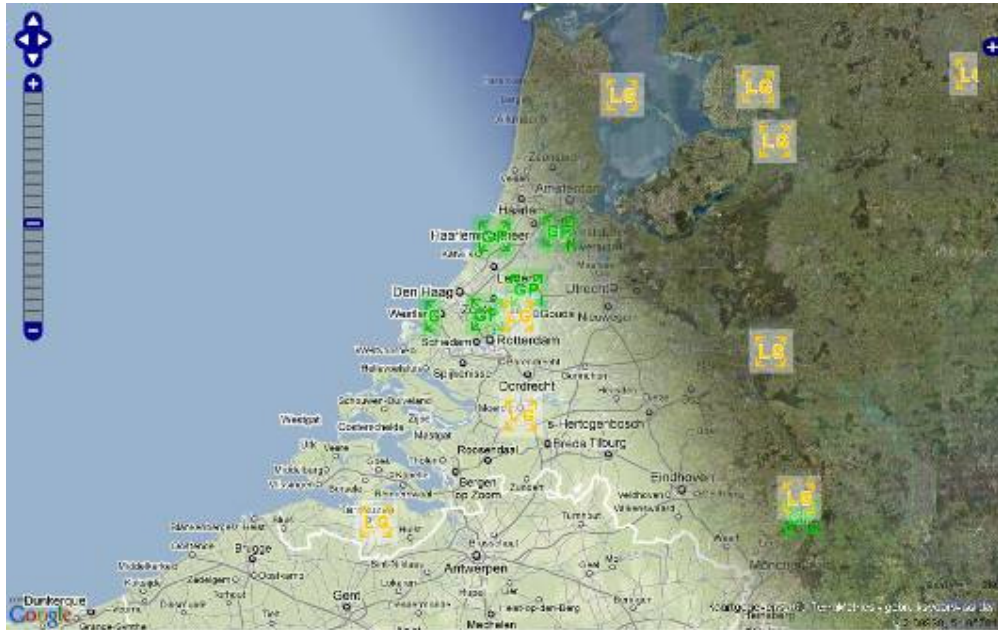
Ehs national



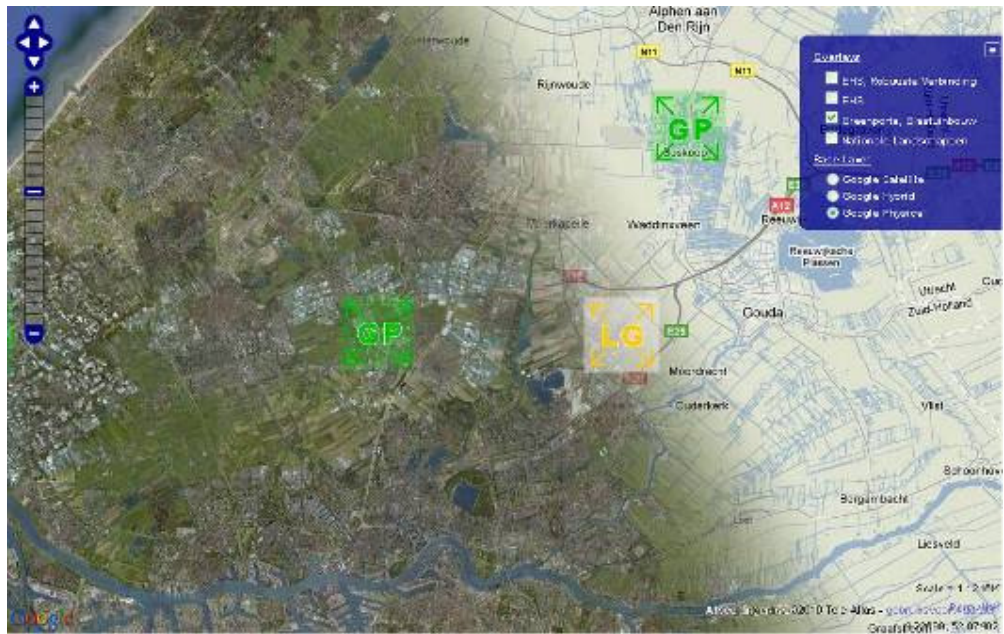
Ehs provincial



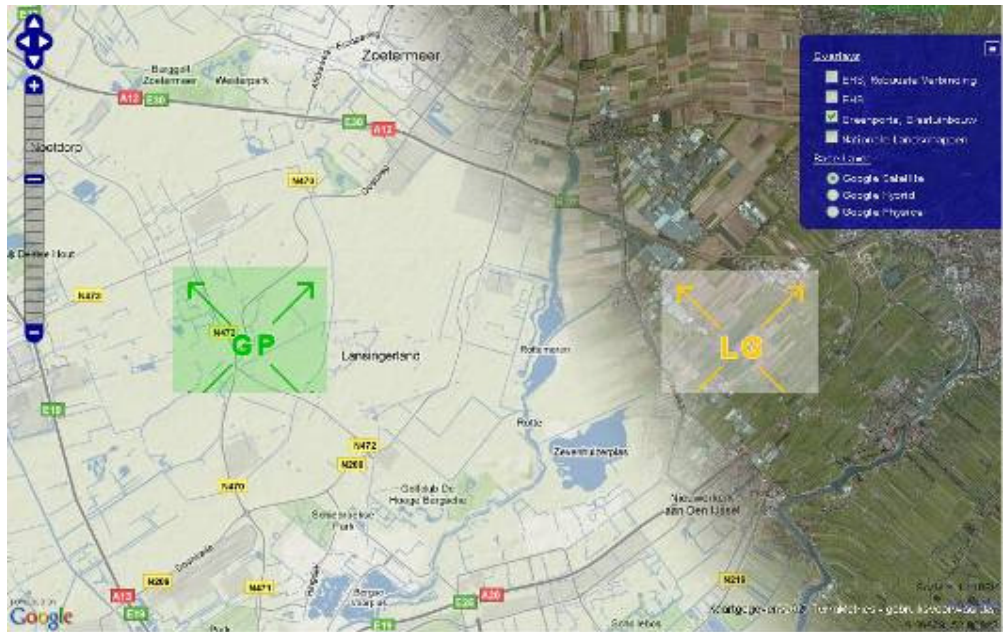
Ehs local



Greenports national



Greenports provincial



Greenports local



National landscapes national









National landscapes provincial



National landscapes local

## **Appendix 4: survey results**

1. Deze vraag gaat over de kaart van de EHS, nr 1. Zorg ervoor  [Diagram maken](#)  [Downloaden](#) dat de lagen "EHS" en "EHS, Robuuste Verbinding" aan staan in de viewer en de overige lagen uit. In de EHS kaart is de vulling van de vlakken minder hard gemaakt. De robuuste verbindingen zijn in de oorspronkelijke kaart als langwerpige vlakken en pijlen getekend. Deze zijn in de viewer door verbindende lijnen vervangen. De objecten passen zich aan aan de schaal waarop de kaart wordt bekeken. Hoe beoordeelt u dit?

		Reactie percentage	Reactie telling
minder duidelijk dan de oorspronkelijke, papieren kaart		5,9%	2
neutraal, ik zie geen voordelen		14,7%	5
de kaart biedt weliswaar meer informatie maar is verwarrend		11,8%	4
de kaart biedt meer informatie en deze is duidelijk		47,1%	16

 [Antwoorden verbergen](#) Overig, nl.:  29,4% 10

- tja, wat moet ik met deze vraag? Thu, May 20, 2010 8:33 AM  [Zoeken...](#)
- Werkt niet (google chrome) Wed, May 19, 2010 3:05 PM  [Zoeken...](#)
- Ik kan het stuk kaart niet vinden waar de vergelijking op betrekking heeft, ook na een tijd zoeken. De legenda lijkt me tamelijk summier. De elementen van de oorspronkelijke kaart zie ik niet terug. De legenda van de oorspronkelijke kaart kan ik niet vinden, dus ik kan deze niet goed vergelijken. Voorzover ik het kan beoordelen lijkt de nieuwe kaart me onvolledig en te grof. Wed, May 19, 2010 9:14 AM  [Zoeken...](#)
- geen idee eigenlijk. Tue, May 18, 2010 9:39 AM  [Zoeken...](#)
1. de ehs gebieden worden niet minder hard door een arcering aan te geven over een zachter gekleurde ondergrond. 2. De verbindingen lijken op fiets/wandelpaden en suggereren exacte ligging ! Door diagonale arcering en onderbroken lijnvoering van de verbindingen vind ik het beeld onrustiger. (beleids)vraag hierbij is ook hoe exact de ehs aangegeven kan en moet worden. In de oorspronkelijke kaart waren de verbindingen met dikke pijlen aangegeven Mon, May 17, 2010 1:37 PM  [Zoeken...](#)
- Dikke lijnen zijn stippellijnen niet. Kleur moet groen zijn Wed, May 12, 2010 6:04 PM  [Zoeken...](#)
- rustiger beeld, is prettiger lezen Wed, May 12, 2010 8:06 AM  [Zoeken...](#)
- ik zie andere informatie, die ik niet kan rijmen met de oorspronkelijke kaart Tue, May 11, 2010 7:57 PM  [Zoeken...](#)
- In de buurt van Naarden zie ik een aantal zeer kleine vlakken "EHS". Als je globaal iets wilt weergeven moet je denk ik dit soort gedetailleerde info weglaten en bijvoorbeeld ook het maximale inzoomniveau hoger instellen. Wed, May 5, 2010 6:19 AM  [Zoeken...](#)
- ik zou dan weleens de oorspronkelijke kaart willen zien. Die ken ik niet dus ik kan moeilijk beoordelen Tue, May 4, 2010 12:59 PM  [Zoeken...](#)

beantwoorde vraag 34  
overgeslagen vraag 1



2. Deze vraag gaat over de kaart "Greenports". Zorgt u ervoor [Diagram maken](#) [Downloaden](#) dat alleen die laag aan staat in de viewer. Door op kaart 2 te klikken onderaan, kunt u de oorspronkelijke, papieren kaart bekijken en vergelijken met in de viewer. De kleine symbolen uit de oorspronkelijke kaart verwijzen niet naar precieze locaties maar naar gebieden waar een ontwikkeling mogelijk is. In de viewer zijn ze vervangen door symbolen die meer verwijzen naar een groter gebied. Hoe beoordeelt u dit?

		Reactie percentage	Reactie telling
minder duidelijk dan de oorspronkelijke kaart.		6,9%	2
neutraal, geen verschil in duidelijkheid.		13,8%	4
duidelijker dan de oorspronkelijke kaart		20,7%	6
uit de kaart blijkt beter dat het om gebieden gaat waar een ontwikkeling mogelijk is in plaats van precieze locaties.		37,9%	11
de kaart biedt meer informatie en deze is duidelijk.		10,3%	3
<a href="#">Antwoorden verbergen</a> Overig, nl.:		20,7%	6

- greenports gaan over bundeling van oa glastuinbouw pijlen naar binnen zouden beter zijn... Wed, May 26, 2010 2:39 PM [Zoeken...](#)
- Werkt niet (google chrome) Wed, May 19, 2010 3:06 PM [Zoeken...](#)
- toch nog gewend aan de oude sympolen. Nieuwe symbool vind ik niet heel aantrekkelijk Wed, May 19, 2010 9:57 AM [Zoeken...](#)
- Ik zie geen enkel verband tussen de oude papieren kaart en de nieuwe kaart. De legenda van de oude kaart ontbreekt dus die kan ik niet vergelijken. De legenda van de nieuwe kaart vind ik uiterst summier. Wed, May 19, 2010 9:17 AM [Zoeken...](#)
- Tja, wat wil je (ruimtelijk/beleidsmatig) aangeven ? Zo geef je aan dat de glastuinbouw naar buiten kan/mag uitgroeien. Maar is dat zo ? Behalve de sector ziet niemand graag de glastuinbouw expanderen. Zowel bezien vanuit de gewenste centrumfunctie (dwz alles bij elkaar wat de glastuinbouw nodig heeft om goed te kunnen functioneren, logistiek en kennis) als vanuit de (ruimtelijke) concentratiegedachte (zuinig ruimtegebruik) zou je de pijlen eerder naar binnen willen laten wijzen ! Je zou dan eerder het gebied willen aangeven waarbinnen de glastuinbouw zich kan/mag ontwikkelen. Dit symbool vind ik niet duidelijk en te vrijblijvend.... Mon, May 17, 2010 1:53 PM [Zoeken...](#)
- Gaat om een indicatieve aanduiding. Symbool is nu te complex geworden Wed, May 12, 2010 6:07 PM [Zoeken...](#)

beantwoorde vraag 29  
overgeslagen vraag 6

3. Deze vraag gaat over de kaart "Nationale Landschappen". [Diagram maken](#) [Downloaden](#)  
 Zorgt u ervoor dat alleen die laag aan staat in de viewer. Door op de kleine kaartjes te klikken onderaan, kunt u de oorspronkelijke, papieren kaart bekijken en vergelijken met het kaartbeeld in de viewer. In het voorstel voor de Nationale Landschappen kaart is onzekerheid gevisualiseerd. De grenzen van de nader te begrenzen gebieden zijn vervaagd. De definitief begrensde gebieden worden wel met een harde grens getoond. Hoe beoordeelt u dit?

		Reactie percentage	Reactie telling
minder duidelijk dan de oorspronkelijke kaart		6,9%	2
neutraal, ik zie geen voordelen		3,4%	1
de kaart biedt weliswaar meer informatie maar is verwarrend		24,1%	7
de kaart biedt meer informatie en deze is duidelijk		51,7%	15
<a href="#">Antwoorden verbergen</a> Overig, nl.:		24,1%	7

- op zich is de visualisatievrom duidelijker, alleen mogen provincies de begrenzing ook kleiner maken, dus deze visualisatie is niet geheel terecht.. het binnen gebied zou ook "onzeker" weergegeven kunnen worden Wed, May 26, 2010 2:40 PM [Zoeken...](#)
- Werkt niet (google chrome) Wed, May 19, 2010 3:06 PM [Zoeken...](#)
- Weer: ik zie geen enkel verband tussen de oude kaart en de nieuwe. De nieuwe is uiterst summier en de legenda onvoldoende. Deze kaart doet geen recht aan het beoogde landelijke beleid. Wed, May 19, 2010 9:19 AM [Zoeken...](#)
- Indien een NL is begrensd dan is dat gebied met een kleur aan te geven of met een contour. Beide is dan wellicht niet nodig. Bij een nog te begrenzen NL is het lastiger en zou je zoals hier gedaan een overgangszone kunnen aangeven. Maar het zou ook een onderbroken lijn kunnen zijn. Probleem daarbij is echter waar je overgangszone of de onderbroken lijn aangeeft. Dat is dan weer afhankelijk per gebied of dat meer of minder exact kan. Bij grote onduidelijkheid zou het dan ook een symbool kunnen zijn. Mon, May 17, 2010 2:31 PM [Zoeken...](#)
- Donkerdere kleur geeft juist meer intensiteit aan: dus kiezen voor een lichtere kleur? Ik zou het verschil laten zien door bij de begrensde gebieden de omlijning weer te geven zoals dat nu gedaan is en de andere gebieden geen omlijning te geven maar wel dezelfde vlakkleur. Dan blijft het feit dat het om een zelfde gebied gaat duidelijk. Wed, May 12, 2010 6:11 PM [Zoeken...](#)
- Nu is duidelijker wat nog niet definitief is e wat wel Wed, May 12, 2010 8:09 AM [Zoeken...](#)
- ik vind de duidelijkere structuur van nederland onder de gekleurde gebieden meer houvast bieden en daardoor minder vaag. Tue, May 11, 2010 8:02 PM [Zoeken...](#)

beantwoorde vraag 29  
 overgeslagen vraag 6

4. De voorstellen hebben een visualisatie die zich aanpast aan [Diagram maken](#) [Downloaden](#) de schaal waarop de kaart wordt getoond: Lokaal, Regionaal (provinciaal) en Nationaal. Zie ook de legenda, via de knop onderin het scherm. Hoe beoordeelt u dit?

		Reactie percentage	Reactie telling
Verwarrend: objecten moeten er op elke schaal hetzelfde uitzien.		3,6%	1
Positief: Het maakt duidelijk dat het beleid niet op elke schaal dezelfde uitwerking heeft.		64,3%	18
Het is beter om kaarten alleen te tonen op de schaal waarvoor het beleid is ontwikkeld.		21,4%	6
<a href="#">Antwoorden verbergen</a> Overig. nl.:		28,6%	8

1. geen materiaal omdat het niet werkt Wed, May 19, 2010 3:07 PM [Zoeken...](#)
2. voor de 'kenner' is het duidelijk dat er bij in/uit zoomen meer/minder info wordt getoond. Ik denk dat dat voor een burger nog wel lastig te begrijpen is Wed, May 19, 2010 9:59 AM [Zoeken...](#)
3. Het inzoomen levert voorzover ik het kan beoordelen geen gedetailleerdere informatie op. Ik zie hetzelfde als op de andere schalen of doe ik iets niet goed? Wed, May 19, 2010 9:20 AM [Zoeken...](#)
4. Dat is puur afhankelijk van de status en beleidsruimte van het onderwerp. Een nog niet begreemd nationaal landschap of ecologische verbinding kun je op lager schaalniveau niet nauwkeuriger aangeven dan op hoog schaalniveau ! Dat kan wel indien deze gebieden begreemd zijn, dan is het wel interessant om het op lager schaalniveau te laten zien. Mon, May 17, 2010 2:39 PM [Zoeken...](#)
5. De symbolen zijn te complex nationale schaal en lopen over elkaar heen, bovendien ziet het eruit of er uitgezoomd wordt. Wed, May 12, 2010 6:13 PM [Zoeken...](#)
6. blijft toch uitkijken op welke schaal gewenst is om te laten kijken Wed, May 12, 2010 8:13 AM [Zoeken...](#)
7. dit is wel wat je verwacht, als je inzoomd, wil je meer informatie. Maar het moet wel kloppende informatie zijn. Tue, May 11, 2010 8:05 PM [Zoeken...](#)
8. De suggestie wordt gewekt dat er qua status verschillen zijn. Dus dat het een nationaal is bepaald en een ander bv lokaal. Dit is niet zo. Mon, May 10, 2010 6:33 AM [Zoeken...](#)

**beantwoorde vraag** 28  
**overgeslagen vraag** 7






5. Bij een analoge kaart is de ondergrond statisch en in het geval van een nationale kaart is alleen een sterk gegeneraliseerde kaart zichtbaar. In de viewer wordt gebruik gemaakt van ondergronden van Google Maps. Bij het inzoomen toont de ondergrond meer detail. Hoe beoordeelt u dit? [Diagram maken](#) [Downloaden](#)

		Reactie percentage	Reactie telling
Het komt de nauwkeurigheid ten goede: je ziet precies waar een grens uit een nationaal plan ligt.		22,2%	6
Het leidt tot schijnnaauwkeurigheid: het is niet wenselijk dat een nationaal plan op "straatnivo" wordt geïnterpreteerd.		40,7%	11
Het zou beter zijn als de ondergrond ook bij sterk inzoomen weinig detail zou tonen.		11,1%	3
Nationale plannen moeten nauwkeuriger worden gemaakt, zodat ze ook op lokale schaal goed raadpleegbaar zijn.		14,8%	4
<a href="#">Antwoorden verbergen</a> Overig, nl.:		37,0%	10

- Als de beleidskaarten goed weergegeven zouden worden zou het inzoomen met de ondergronden van google een verrijking betekenen. Wed, May 19, 2010 9:22 AM [Zoeken...](#)
- Op zich prima indien dat ook mogelijk is; zie ook antwoord op vorige vraag. Hangt af van status en begrenzing van het beleidsthema. Uiteindelijk moet een nationaal plan doorwerken naar provincie en gemeente niveau. Daar hoort een andere aanduiding en ondergrond bij. Mon, May 17, 2010 2:43 PM [Zoeken...](#)
- Dat is fantastisch: het juiste kaartbeeld bij de juiste schaal! Wed, May 12, 2010 6:15 PM [Zoeken...](#)
- De mogelijkheid en detail van inzoomen kan misschien wel gekoppeld worden aan het soort kaart dat geraadpleegd wordt. Als gebied met niet-vasgestelde grens geraadpleegd wordt dan voorkomen dat ingezoomd kan worden tot zeker detail. Wed, May 12, 2010 8:17 AM [Zoeken...](#)
- Alleen als de info klopt Tue, May 11, 2010 8:06 PM [Zoeken...](#)
- Gezien het onderwerp weet je dat het ongeveer is. Toch is het handig dat je vast kunt inzoomen zodat je kunt bepalen of een bepaalde plaats gebied of perceel zeker wel of zeker niet in de 'zone' valt. Mon, May 10, 2010 8:51 PM [Zoeken...](#)
- Je moet duidelijk kunnen maken of een gedetailleerd punt 100 % zeker buiten of juist 100 % zeker binnen een gebied ligt. Het kan kan er ook tolerantie liggen waarbij je de mate van waarschijnlijkheid probeert te visualiseren met behulp van een fuzzy grens. Fri, May 7, 2010 10:50 AM [Zoeken...](#)
- Bij deze kaarten kun je niet ver genoeg inzoomen. Op een gegeven moment krijg ik de volgende melding: "We hebben op dit zoomniveau helaas geen kaarten voor deze regio. U kunt uitzoomen voor een breder overzicht." Waardoor het voordeel van digitale kaarten, om naar je eigen adres te zoeken, word belemmerd. Thu, May 6, 2010 7:08 AM [Zoeken...](#)
- Zoals bij vraag 1 al aangegeven: je hebt zelf het maximale en minimale zoomniveau in de hand. Wed, May 5, 2010 6:26 AM [Zoeken...](#)
- Vind het moeilijk hier een keuze te maken. De nauwkeurigheid bij inzoomen hangt ook samen met de schaal en ondergrond waarop de begrenzingen worden ingetekend. Nationaal beleid wordt echter gekenmerkt door een meer globaal karakter. In het algemeen ben ik voorstander voor meer gedetailleerde ondergronden bij het inzoomen. Tue, May 4, 2010 6:49 PM [Zoeken...](#)

beantwoorde vraag 27  
overgeslagen vraag 8

6. In principe kunnen in de viewer ook eenvoudig lokale of provinciale plannen tegelijk worden getoond met de nationale plannen, hoewel deze doorgaans op een sterk afwijkende schaal zijn getekend. Hoe beoordeelt u deze mogelijkheid? [Diagram maken](#) [Downloaden](#)

		Reactie percentage	Reactie telling
Prettig om plannen van verschillende schaal te kunnen vergelijken (en zo het schaalprobleem op te lossen)		30,8%	8
Vergelijken is goed, mits de herkomst en schaal van de kaartlagen helder is en bij beoordeling wordt meegewogen.		46,2%	12
Schaal en "hardheid" van vlakken blijkt onvoldoende uit de kaart: schaalprobleem wordt hiermee juist groter		3,8%	1
Dit leidt tot een verkeerde manier van vergelijken en conclusies trekken		15,4%	4
Kaartbeeld vertroebelt te veel, goede beoordeling niet meer mogelijk		0,0%	0
<a href="#">Antwoorden verbergen</a> Overig, nl.:		26,9%	7

1. Kan alleen met vergelijkbare ruimtelijke plannen of thema's. Het lijkt me wel lastig om de leesbaarheid goed te krijgen Mon, May 17, 2010 2:48 PM [Zoeken...](#)
2. Dan zou je de plannen alleen moeten tonen op het schaalniveau waarop ze betrekking hebben. Wed, May 12, 2010 6:16 PM [Zoeken...](#)
3. De kans van verkeerde manier van vergelijken en conclusies trekken is hierbij wel aanwezig. Wed, May 12, 2010 8:19 AM [Zoeken...](#)
4. te weinig affiniteit hiermee om dit te kunnen beoordelen Tue, May 11, 2010 8:07 PM [Zoeken...](#)
5. Op dit moment geen mogelijkheid om lokale plannen te bekijken. Hierdoor geen gegevens om deze vraag te beantwoorden. Thu, May 6, 2010 7:09 AM [Zoeken...](#)
6. Ambivalent dus. Ik denk ook dat je op dit punt onderscheid moet maken tussen beleidsmakers en andere afnemers. Overigens is generaliseren van een gestandaardiseerd product als de bestemmingsplankaart is wellicht mogelijk en zinvol. Wed, May 5, 2010 6:36 AM [Zoeken...](#)
7. dit is toch meer iets voor de betrokken ambtenaren dan voor mij om te beoordelen Mon, May 3, 2010 11:47 AM [Zoeken...](#)

beantwoorde vraag 26  
overgeslagen vraag 9

7. vindt u het wenselijk om onzekerheid in de visualisatie van ruimtelijke plannen zichtbaar te maken? [Diagram maken](#) [Downloaden](#)

		Reactie percentage	Reactie telling
ja, zonder meer.		66,7%	18
ja, echter alleen wanneer het plan wordt geraadpleegd op een andere dan de "eigen" schaal.		18,5%	5
nee, het is beter om plannen alleen op de "eigen schaal" te tonen (en dus inzoomen uitschakelen of beperken).		0,0%	0
nee, het is niet nodig of wenselijk, onzekerheid blijkt wel voldoende uit het plan zelf.		3,7%	1
<a href="#">Antwoorden verbergen</a> Overig, nl.:		18,5%	5

1. Wat wordt bedoeld met "onzekerheid" in ruimtelijke plannen? Wed, May 19, 2010 9:24 AM [Zoeken...](#)
2. geen echte mening omdat afhankelijk van wie waarom en wanneer de kaarten geraadpleegd worden Tue, May 18, 2010 9:42 AM [Zoeken...](#)
3. een standaard voor verbeelding zodat we het allemaal op dezelfde wijze de onzekerheid aangeven is een aanrader. Voor een deel is dit al opgelost in de RO Standaarden. Tue, May 18, 2010 9:16 AM [Zoeken...](#)
4. Het moet geïnteresseerden en gebruikers duidelijk zijn wat de aanduiding en status van een gebied of plan behelst, op elk schaalniveau. Dat voorkomt grote onrust. Mon, May 17, 2010 3:02 PM [Zoeken...](#)
5. Volgens mij is de onzekerheid wel te verwaarlozen. Mensen die deze kaarten raadplegen weten doorgaans wel de toepasbaarheid van deze kaarten. Mensen die hier niet doorgaans mee werken kunnen eventuele vragen stellen bij de verantwoordelijken. Thu, May 6, 2010 7:11 AM [Zoeken...](#)

beantwoorde vraag 27  
overgeslagen vraag 8

8. De onzekerheid in ruimtelijke plannen hangt vaak samen met [Diagram maken](#) [Downloaden](#) de "hardheid" en de status van planobjecten. Dit komt tot mede uitdrukking in de benaming van de objecten. Termen als "concept", "ontwerp" of "zoekgebied" hebben een eigen hardheid of onzekerheid. Denkt u dat het mogelijk is om voor de onzekerheid van plannen (bijvoorbeeld structuurvisies) een standaard voor de visualisatie vast te stellen, zodat uit de kaart blijkt hoe zeker de objecten zijn?

		Reactie percentage	Reactie telling
ja, geen probleem;		11,1%	3
ja, mits overeenstemming wordt bereikt over de te gebruiken termen / soorten hardheid en de daarbij horende verbeelding;		63,0%	17
wellicht is het mogelijk, maar dit beperkt de vrijheid van beleid;		14,8%	4
nee, plannen zijn onderling te zeer verschillend;		11,1%	3
<a href="#">Antwoorden verbergen</a> Overig, nl.:		18,5%	5

- Ik denk dat het mogelijk is om alles wat met papieren plannen uitgedrukt wordt ook met digitale plannen uit te drukken. Dit vereist dan wel een betere representatie dan de hier getoonde. Wed, May 19, 2010 9:25 AM [Zoeken...](#)
- in samenwerking met de praktijk. Echter de praktijk is nog helemaal niet zo lang bezig met digitale structuurvisies en heeft daardoor mogelijk ook nog geen duidelijk beeld hoe dit (in overeenstemming) kan worden opgelost. Tue, May 18, 2010 9:19 AM [Zoeken...](#)
- Zie mijn reactie op voorgaande vragen; het zal wel mogelijk zijn, maar of het ook altijd goed onderscheidend te maken is.. lijkt me wel een uitdaging Mon, May 17, 2010 3:05 PM [Zoeken...](#)
- geen mening Tue, May 11, 2010 8:07 PM [Zoeken...](#)
- Technisch is alles mogelijk. De vraag is hoe ver je daar in kan gaan. Het koppelen van de hardheid aan bijvoorbeeld tijd, of aan andere ontwikkelingen zou de kaart zelfs dynamisch maken. Je kunt je dan afvragen in hoeverre zo een kaart nog te ontwerpen / tekenen / weer te geven is. Wed, May 5, 2010 6:54 AM [Zoeken...](#)

beantwoorde vraag 27  
overgeslagen vraag 8

9. wat is uw achtergrond / soort organisatie [Diagram maken](#) [Downloaden](#)

		Reactie percentage	Reactie telling
rijk of daaraan verbonden dienst		25,9%	7
provincie		3,7%	1
gemeente		18,5%	5
waterschap		7,4%	2
stedebouwkundig adviesbureau		11,1%	3
adviesbureau overig		22,2%	6
onderwijs / onderzoek		11,1%	3
<a href="#">Antwoorden verbergen</a> anders, nl.:		18,5%	5

- |  |                           |                           |
|--|---------------------------|---------------------------|
| 1. regionaal samenwerkingsverband      | Mon, May 10, 2010 1:39 PM | <a href="#">Zoeken...</a> |
| 2. software leverancier / ontwikkelaar | Fri, May 7, 2010 10:53 AM | <a href="#">Zoeken...</a> |
| 3. Zelfstandig ondernemer              | Fri, May 7, 2010 9:35 AM  | <a href="#">Zoeken...</a> |
| 4. maker van software voor RO          | Wed, May 5, 2010 6:55 AM  | <a href="#">Zoeken...</a> |
| 5. huisvrouw                           | Mon, May 3, 2010 11:49 AM | <a href="#">Zoeken...</a> |

beantwoorde vraag	27
overgeslagen vraag	8