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PUBLIC PARTICIPATION GIS: AN IMPORTANT TOOL IN ENVIRONMENTAL PLANNING

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ABSTRACT

The protection and enhancement of the environment is the main aim of most environmental planning, and the use of geographic information as well as public participation can improve the quality of both the processes and the decisions. The current paper describes the role of web-based geographic information in environmental planning and gives an overview over the various approaches to public participation. The current advances in Web-based GIS in many countries contain great possibilities for supporting good governance based on information and knowledge on the one hand and active involvement of the citizens on the other hand. One important precondition for success in this field is a well-informed population with access to the Internet. The overall purpose of this paper is to give an overview of how to utilise geographic information and public participation as natural components in environmental planning. The methods and techniques are illustrated by Danish examples from practical environmental planning. At the end I present some ideas for following up activities.

INTRODUCTION

The protection and enhancement of the environment is the main aim of environmental planning, and it is often emphasised that the use of geographic information and active involvement of the citizens can improve the quality of both the processes and the end decisions. The Conference on Environment and Development (Earth Summit) in Rio de Janeiro in 1992, Principle 10 (United Nations, 1992a) and Agenda 21 (United Nations, 1992b) both called for increased public participation in environmental decision-making and led to the adoption in Europe of the Aarhus Convention (UN ECE, 1998). Besides, Agenda 21 emphasises the role of geographic information in monitoring and analysing the state of environment globally. Therefore, it is important that governments at all levels seriously consider how to fulfil the obligations stated in the international conventions mentioned above. The current advances in Web-based GIS in many countries contain great possibilities for supporting good governance based on information and knowledge on the one hand and active involvement of the citizens on the other hand. One important precondition for success in this field is a well-informed population with access to the Internet. Generally the Nordic countries have been in the forefront concerning penetration and use of Information and Communication Technology (ICT), and therefore I have used examples from this part of the world in the current paper. The overall purpose of this paper is to give an overview of how to utilise

geographic information and public participation as natural components in environmental planning. The paper is divided into 5 parts. After the introduction I address various aspects of environmental information – not at least the spatial dimension of environmental information. The next section deals with public participation in spatial and environmental planning with particular focus on the Internet and Public Participation GIS. The following section describes how public participation GIS have been used in practical environmental planning. Finally, I have some concluding remarks and present for you some ideas for following up activities.

ENVIRONMENTAL INFORMATION

Access to environmental information, public participation in environmentally relevant decision-making, as well as access to courts for environmental stakeholders, is essential for enhancing public awareness and for the development and implementation of widely supported environmental policies. The Rio Declaration (United Nations, 1992a) and Agenda 21 (United Nations, 1992b) link information and sustainable development. Principle 10 of this declaration reads:

Environmental issues are best handled with the participation of all concerned citizens, at the relevant level. At the national level, each individual shall have appropriate access to information concerning the environment that is held by public authorities, including information on hazardous materials and activities in their communities, and the opportunity to participate in decision-making processes. States shall facilitate and encourage public awareness and participation by making information widely available. Effective access to judicial and administrative proceedings, including redress and remedy, shall be provided.

Chapter 40 of Agenda 21 is dedicated to “Information for decision-making” and emphasizes the role of remote sensing and geographic information systems:

..... Countries and international organizations should make use of new techniques of data collection, including satellite-based remote sensing.

..... National and international data and information centres should set up continuous and accurate data-collection systems and make use of geographic information systems, expert systems, models and a variety of other techniques for the assessment and analysis of data.

The Aarhus Convention (UN ECE, 1998) grants the public rights and imposes on public authorities’ obligations regarding access to information and public participation and access to justice. According to the Aarhus Convention, environmental information means any information in written, electronic or any other material on the state of the environment concerning air and atmosphere, water, soil, land, landscape and natural sites, biological diversity and its components, genetically modified organisms as well as the interaction among these elements. Furthermore, energy, noise, environmental agreements, policies, legislation, plans as well as cost-benefit and other economic analyses used in environmental decision-making are considered as environmental information. Finally, environmental information refers to the state of human health and safety, conditions of human life, cultural sites and built structures if they are affected by the state of the environments.

Following this definition of environmental information it is obvious to raise the question: What kind of information is not considered as belonging to environmental information?

Generally information about air pollution or wild animals is more accepted as part of environmental information, than for example information on the use of pesticides in agriculture, which might be classified as private information even with some commercial aspects by the farmers.

Environmental problems are perceived as interconnected and thus call for a holistic approach for their solution. Strategic Environmental Assessment is a systematic process for evaluating the environmental consequences of proposed policy, plan or programme initiatives, in order to ensure they are fully included and appropriately addressed at the earliest appropriate stage of decision making on par with economic and social considerations.

The Spatial dimension

Almost all themes of environmental information (e.g. water, forestry, climate, soil, biodiversity etc.) have a spatial dimension. All interactions between the living environment of the citizens and the effects of the environmental policies occur at certain spots on Earth, which can be represented by x, y (and optionally z) co-ordinates. This common spatial dimension is very important for environment and other sectors that need to integrate in environmental considerations. Thus, for a region, whether a municipality, country, transboundary region, continent or the whole world, there can be important spatial heterogeneity or differences, which in many cases deserve special attention. Surprisingly, the spatial dimension has often been neglected or been given low priority by groups preparing environmental or sustainable development indicators.

The temporal dimension

Evaluating environmental trends requires information from a longer period of time. Past trends are analysed in order to understand the present and to prepare scenarios of the future evolution. Developing an efficient environmental model is not easy. Most environmental processes show complicated interrelations, both in time and space, leading to numerical models with a complex mathematical structure. Also, environmental models require huge amounts of data, often coming from many sources. In most cases Geographic Information Systems (GIS) are used to collect the data of different qualities and formats for use in the model. Because environmental processes are dynamic, they include several characteristics, such as the speed or rate of change, the size of the mass involved in the change and thus the inertia of the process, and the significance of the amount and rate of change relative to the initial and resulting states.

PUBLIC PARTICIPATION

Public participation practice is a growing part of environmental decision-making. The main purpose of environmental decision-making and thus the main purpose of public participation in this matter is to achieve protection, conservation, and wise management of the environment. This can only be achieved if the proponent properly collects (and acts upon) evidence, opinions and perspectives from all the interested or affected stakeholders, who are to be fully involved in the decision-making process, and from the earliest possible opportunity.

The level at which the public is involved varies with the relevant legislation, and the attitude of the other stakeholders. Often it just means informing the public of a previously, made decision and asking for comments, which may or may not be heeded. Sometimes it means informed consultation. For public participation to be effective at any level, it requires the public to be well informed and kept aware of the possibility of participation. This requires a pro-active approach from the relevant public authorities.

Taxonomies

Arnstein (1969) claims that the involvement of the public in decision-making represents a redistribution of power from the authority to the citizens. He describes the public participation by a 'ladder' with 8 rungs each representing the level of citizen participation. This so-called ladder of public participation has 8 rungs divided into three main groups. The uppermost ladder representing 'citizen power', involves public-authority partnerships in which citizens are in control, or can veto agency decisions.

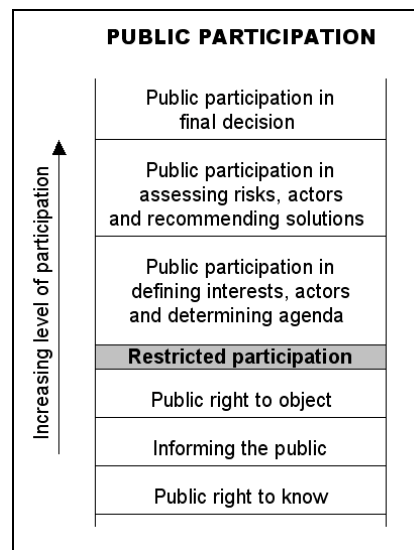


Figure 1: Weideman and Femers (1993) ladder of public participation.

Based on the Arnstein ladder, Weideman and Femers (1993) developed a revised ladder of public participation, where the involvement increases with the level of access to information as well as the citizen's rights in the decision-making process (fig. 1). According to Weideman and Femers, the public involvement increases as the authority grant the citizens rights higher in the ladder, which can only be reached by full filling all the requirements of the lower steps in the ladder. In most cases, the public participation is limited to the right to object, but the current and future information and communication technologies will provide opportunities to helping the degree of involvement to move further up in the public participation ladder.

Inherent in their conceptualisation lies that simply informing the public is a kind of participation although access to information and participation is clearly distinct matters. Tulloch and Shapiro (2003) explored possible combinations that could exist between the presence and absence of access and participation. They identified 4 different situations: 1) No or low levels of access, 2) High levels of access, 3) No or low levels of participation, and 4) High levels of participation. This resulted in a simplified comparison of participation and

access that allowed a quick categorisation of successful and unsuccessful projects into 4 types (figure 2).

The first type describes a combination of no or low level of access and no or low level of citizen participation. As an example of this Tulloch and Shapiro mention the process of siting a military facility where access to information as well as participation in the decision is impossible due to national security. Fortunately, these situations happen rather rare in the open Western democracies. The second type is characterised with high level of access to information but low level of citizen involvement. The traditional way of doing environmental impact assessment is a good example on this category. Huge amounts of data, map, and analyses of proposed alternatives are supplied to the public, but a real participation of the citizens is not possible because of the complexity of the provided information or reluctance in the authority to listen to the public's opinions and proposal. Type III represents a perhaps, unusual situation where the level of public participation is rather high whereas the level of access to information is absent or low. The final category, type IV is a combination of a high level of access to information and a high degree of public participation as well. This could be the situation where a group – an NGO or similar - with sufficient expert knowledge retrieve and possibly download all available information and make their own calculations on impact assessment and scenario analysis. Due to the comparatively high level of information and knowledge on both sides, the right foundation for a fruitful active public participation will be present. The taxonomy described by Tulloch and Shapiro (2003) has much more precise definitions and therefore more suited to categorise various practical implementations of public participation in environmental decision-making than the ladders of public participation developed by as well Arnstein (1969) as Weideman and Femers (1993).

	No or Low Levels of Access	High Levels of Access
No or Low Levels of Participation	I	II
High Levels of Participation	III	IV

Figure 2: Combinations of the presence and absence of access and participation.
- after Tulloch and Shapiro (2003).

Internet use, the digital divide and inequality

The open structure and architecture of the Internet provide a rather simple mechanism by which environmental information can be released to the public at relatively low cost for as well provider (the public authority) as the consumer (the citizens).

Generally the Nordic countries have been in the forefront concerning penetration and use of Information and Communication Technology (ICT). The statistical offices in the Nordic

countries have made a survey in 2002 of the use of ICT in Denmark, Finland, Iceland, Norway and Sweden (Nordic Council of Ministers, 2002). According to this survey, the highest proportion of the population with Internet access at home is in Iceland with 73%, followed by Sweden with 68%. The corresponding figure for Denmark and Norway is 61%, whereas Finland has the lowest proportion with 53%. For the Nordic countries as a whole 62% of the population has access to the Internet. These figures are among the highest in the world, and only the Netherlands, USA and Canada have an Internet penetration of similar size.

Despite the general spread of information and communication technologies, large parts of the world remain technologically disconnected. This so-called "digital divide", threatens to cut off populations from good jobs and the chance to participate in the affairs of the broader society. Among the Nordic countries the digital divide exists but perhaps less pronounced than in other countries. Thus, gender does not have any significant effect on the use of the Internet, but age have more remarkable effects on the use. For example in Denmark, 68 % of citizens aged 16-29 have access to the Internet, whereas the corresponding figure for senior citizens (over 60 years) is 33 % (Nordic Council of Ministers, 2002). A similar inequality is related to education. Nordic persons with only primary education have Internet user rate between 44 % (Finland) and 50 % (Sweden) while academic and advanced professionals have user rates between 69 % and 82 % (Sweden). One important finding in the report from the Nordic Council of Ministers are that if a person lives in a household with children he or she will be more likely to have access to computer and the Internet than those living in households without children. Thus children can be considered as the key to close the digital divide. However, solely relying on Internet based system for public participation may have to potential to strengthen the voice of younger, male, higher-income people who have more frequent access to the Internet, and thus possibly overriding the voice of the poor.

PUBLIC PARTICIPATION GIS

Increased public involvement in the definition and analysis of questions tied to location and geography is the domain of Public Participation GIS (PPGIS). This approach facilitates the meaningful introduction of appropriate forms of spatial information and related technologies for widening public participation in the planning process. As mentioned earlier, the acceptance of GIS as an appropriate technology for handling environmental information is recognised in Agenda 21. Many opportunities for public participation are laid down in the environmental legal framework and Internet GIS can support and facilitate citizen involvement in environmental planning and decision-making. It is important to avoid hearing from only the activists or the powerful elite, and in order to get the widest sweep of opinions and information, authorities must reach out into the community. Internet GIS can surmount at least partly this obstacle although the powerful elite may still dominate the chat room, but the use of the Internet at least allows the more cautious and reserved citizens to express their opinions (Kingston et al., 2000).

Public participation GIS has proved to be an effective means to increase community participation in the evaluation process. Based on the level of contents and functionality a PPGIS could have various levels of service representing various levels of citizen involvement and interactivity. Peng (2001) provides a framework of an Internet based public participation system and categorises the provided level of service based on the information content and interactivity (figure 3). Referring to figure 3, the level of service in a PPGIS ranges from the

lowest level at the upper-left corner to the highest level at the lower-right corner. The lowest level of service only deals with information distribution, whereas the highest level of service offer the citizens a much more active role in building scenarios and suggesting alternatives. Referring to paragraph 3.1 there is a clear similarity between Arnstein's ladder of public participation and Peng's framework.

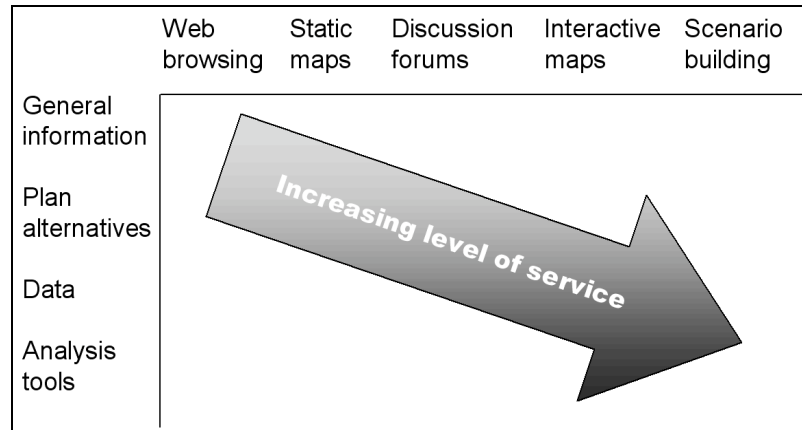


Figure 3. Framework for web-based public participation systems - after Peng (2001).

Schiffer (1992) asserts that increased access to analytical tools, information, and collaboration faces three barriers:

- Inadequate human-computer interface;
- Difficulties accessing and filtering the vast amounts of information coming from maps, statistical data, photographs, video clips etc;
- Tools for environmental decision-making are not developed to address collaborative work, but designed to support the individual analysts and decision-makers.

Schiffer therefore proposes what he calls computer-supported collaborative work that allows group participation and which incorporates all three dimensions of analytical tools, information and collective cognition.

Carver (2001) has taken another approach by illustrating the complicated issue of public participation and geographic information by a SWOT analysis. As stated above it is obvious that decision problems concerning the environment have strong spatial components, and local people usually know their local area better than anyone else and they can thus provide detailed insight into local phenomena, which is not available from standard national GI data sets. In this way, incorporation of local knowledge in the decision-making process will be a major strength. An additional strength of public information GIS lies in its ability to visualise environmental information and communicate this information to interested stakeholders. However, there are significant problems incorporating the ordinary citizens in the decision-making process. The main weakness is related to the fact that the public generally do not possess the required knowledge to understand the generally complicated matters related to for example environmental impact assessment balancing environmental protection against mainly economic matters. Furthermore, the public does not have all the relevant information. As stated in both the Aarhus Convention and the Agenda 21 the *real opportunity* for public participation lies in making the citizens more accountable for decisions made by given more responsibility to the public. The *real threats* for the participatory process is related to the antipathy against the politicians and other decision-makers. Although this is a

fact in some European countries, it is not the prevailing situation in for example the Scandinavian countries if we look at the participation at the general elections. However, we should not underestimate the potential feeling among ordinary citizens of why should they be involved if their input would simply be ignored or even worse misused or distrusted.

Nowadays, it is generally accepted that participatory on-line systems will become a useful means of informing the public and to allow access to data and planning tools (on-line GIS) as an additional means of public participation. These will provide mechanisms for the exploration, experimentation and formulation of decision alternatives by the public in future environmental planning processes and have the potential to move the public further up the participatory ladder, although we must be aware of the weaknesses and threats mentioned above.

PPGIS IN ENVIRONMENTAL PLANNING

The widespread adoption of the Internet together with rapid development of software platforms for development of InternetGIS – e.g. ArcIMS and Map Server – has lead to enhanced use of Internet mapping for planning purposes. As mentioned above InternetGIS contain potentials for supporting the public participation in environmental planning. Accordingly, all Danish counties and larger municipalities have already today published maps related to environmental planning on their homepages. However, some public authorities have gone further than just putting static maps on the Internet. These authorities have implemented real Internet based geographical information systems using standard software, but in many cases these rather expensive solutions is only used for dynamic map viewing, enabling the user to pan, zoom and change the map contents. A few authorities have really tried to utilise the power of InternetGIS in the participatory phase of environmental planning. Below, I describe two examples where the authorities have tried to use the Internet to encourage the citizens to take a more active role in the planning process.

Example with interactive maps

In 1999 the Danish government designated the Northern Jutland County to become a national ITC Lighthouse. The Digital North Denmark was a regional IT project, which ran over 3 years with a funding of DKK 170 million granted by the Ministry of Science, Technology and Innovation. The object was to explore the potentials of the network society for all citizens of North Denmark. This was done by accomplish 89 IT projects within various themes. The Active Map of Aalborg, which was carried out by the municipality of Aalborg, is one of these projects and InternetGIS is a vital ingredient in the Active Map of Aalborg. Besides simple map viewing, the aim of the project was pointed towards the interactive potentials of the InternetGIS and making them instrumental for self-service solutions, and a dialogue on local conditions (democracy forums). Editing and adding graphic information and returning it to the Municipality was also in the original project description. The current state of the Active Map of Aalborg only partly fulfils the original visions. The citizen can easily get an overview of the planning rules in force at even the most detailed level using the interactive map, and retrieve associated statistical information. Additionally the user can get insight in new planning proposals and send their comments to the authority directly from the Active Map of Aalborg homepage (figure 4). By pressing the red rectangle the dialog box for inputting comments appear. Thus the Active Map of Aalborg is placed somewhere in the centre of Peng's framework for web-based public participation systems. Although the solution supports

interactive maps with discussion forums for plan alternatives, it contains no tools for scenario building and no possibility for data download. The ITC Lighthouse project is now finished, but a further development of the Active Map of Aalborg will be continued, but at a lower speed due to fewer limited financial resources.

The screenshot shows the website for Aalborg Kommuneplan. The header includes the URL www.aalborg.dk and the title "KOMMUNEPLAN". Navigation links include "Abonner", "Nyheder", "Praktiske oplysninger", "Skriv til Kommunen", "Vejledning", and "Hvad gælder for mig?". A secondary row of links includes "Hovedstruktur", "Kommuneplanrammer", "Bilag", "Planredegørelse", "Lokalplaner", "Andre planer", and "Udskriftslayout".

The main content area is titled "Sydvest-området" and features a map of the region. A legend on the right side of the map lists various land use and infrastructure categories, such as "Baggrund 1", "Baggrund", "Aalborg Kommune", "Limfjorden", "By", "Vej", "Bygning i det åbne land", "Cykelsti langs vej (Fortegnet)", "Stier", "Offentlig sti", "Privat sti", "Vejreservationer", "Planlagte veje", "Overo. kommunale veje", "Amtskommunale veje", "Statslige motorveje", "Eksisterende skove", and "Planlagte projekter".

In the foreground, a comment form is visible. The "Emne:" field contains "Forslag til kommuneplan for Sydøst-området". The "Indsigelse og bemærkninger:" field contains the text: "Dear We are a seriously worried about the noise from the new motorway project just west of our neighbourhood.....". The "Fornavn(e):" field contains "Henning Sten" and the "Efternavn:" field contains "Hansen".

Figure 4: The Active Map of Aalborg.

<http://www.detektiveaalborgkort.dk>

Example with scenarios

Viborg County in Mid-Jutland has gone a step further in their ambitions to involve the citizens in environmental planning. Based on the MapServer Open source development environment for building spatially enabled Internet applications, the county has set up web pages for rather advanced public participation (figure 5). Here the citizen can compare the current water level in Nørre Å valley with the possible level in the future if the stream is narrowed due to reduced green crop cutting. They can compare summer and winter situations. The calculations illustrate the maximum conceivable water level rise. The red areas represent the current situation at wintertime, whereas the green areas illustrate maximum imaginable wintertime flooding in the future. In addition to working with some predefined scenarios on the county homepage, expert users can download all the data for subsequent processing in

their own GIS software (figure 6). Thus Viborg County's system is near to the lower right corner of Peng's framework for PPGIS. At the moment no analysis and flooding calculation tools are available to the public, but the solution provided with predefined scenarios is among the most advanced attempts to encourage the citizens to really participate in the environmental planning process. Easy to use solutions allowing users with less computer knowledge to achieve a usable result should not be underrated. Therefore, Viborg County use a clean user interface, which only contains the most essential tools, needed to interact with the map and retrieve the information. At the same time they allow more advanced users to build their own analyses and define the viewing of results by using the download option. The main disadvantage with the system is very slow update of the map when changing the contents or zooming in and out, but hopefully this will be improved in the next generation of the system.

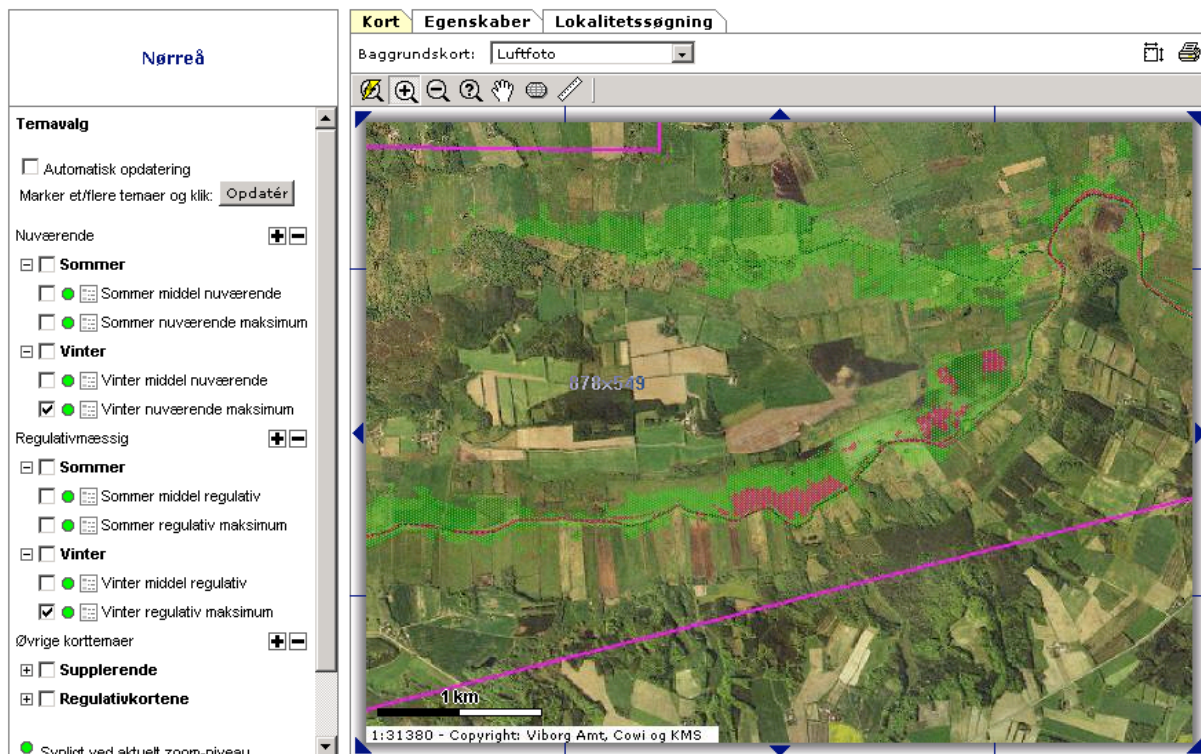


Figure 5: Flooding scenarios around Nørre Å stream.
http://gis.vibamt.dk/arealinfo/AI_Map.asp?Page=NOERREAA

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Figure 6: The download facility at the Viborg County homepage.

CONCLUDING REMARKS

Improved decision-making is perhaps the most promising element in e-Government, and the central idea in all decision-making is how to make the optimum solution and how to get acceptance by the citizens. The current paper has demonstrated how the use of PPGIS can improve the democratic foundation for the decisions taken, by involving the citizens more actively in the decision-making process. Particularly the examples from Viborg County and the municipality of Aalborg deserve particular attention. The rather simple user interfaces permit even non-expert users to express their opinions about new planning proposals (in the example from the municipality of Aalborg), and to compare various scenarios and to discuss them with their family and friends (in the example from Viborg County).

On the other hand we should not be too fascinated of the technological possibilities and forget the *digital divide* as well as the value of face to face discussions between the citizens. Equal opportunities to express their opinions and an open debate between people are the basic foundation for democracy. But having these issues in mind we should not neglect the inherent potential by using PPGIS in environmental planning.

The expected next steps for the authorities will be to let the citizens themselves use web-based geographic information modelling tools to make scenarios and make their own proposal for new plans. Environmental planning often involves complicated technical matters - e.g. environmental impact assessment, and therefore requires new ways of presenting for example scenario tools. On the other hand, new developments within virtual reality give us new methods to visualise the results of modelling efforts in a more easy understandable way.

The next step in our research will be to analyse a) the user's age, gender and social background, b) the user's opinion about the systems and how they use them, and c) and finally how the user's feedback is handled by the authorities. The results will hopefully give us more insight concerning the design of PPGIS to fulfil the citizen's expectations.

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