VISÖ - *Visualization of Infrastructure and Sustainable development in Öresund*

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Abstract

Sustainable growth is a shared goal and challenge for policy-makers at local, regional, national as well as European levels of government. However, due to the complexity and interplay of the driving forces it is often difficult for decision-makers to predict the lasting effects of large infrastructure investments and other significant changes to the land use structure and transport system. In cross-border regions, the difficulties facing decision-makers are even more demanding due to shortage of joint planning tools and institutions.

Substantial research literature confirms the hypothesis that analysis aimed at decision-support in general has limited impact on actual decision-making. One reason might be that effects and results often are evaluated based on complex system analyses and mathematically derived formulas which are often only understood by experts. This, combined with the *lack of coordinated facts, maps and tools* on which alternative development scenarios are formulated and long term planning decisions are ultimately based, constitutes a considerable difficulty for decision-makers at all levels, whether politicians or civil servants.

Project **VISÖ** - *Visualization of Infrastructure and Sustainable development in Öresund* is a joint Swedish and Danish research collaboration to develop *a coordinated planning tool and methodology* – from which alternative development scenarios and strategic infrastructure choices and their effects can be better understood, communicated and visualized in pedagogic illustrations and purposeful dialogues in a cross-border region context. The new platform will ultimate enable planning authorities, politicians and affected communities to better understand and shape decisions regarding the development within a cross-border region in a positive, smarter and greener direction.

Project **VISÖ** is financially supported by EU Interreg IVA. Partners are the Swedish Transport Administration, the Danish Road Directorate, Region Hovedstaden, Region Själland and Region Skåne.

1. Introduction

Future growth of population, economy and transport is a challenge for metropolitan regions in Sweden, Europe and worldwide. In the cross-border Region Öresund alone an additional 400 000 - 800 000 inhabitants or more are expected by the year 2045 (ÖRIB, 2008).
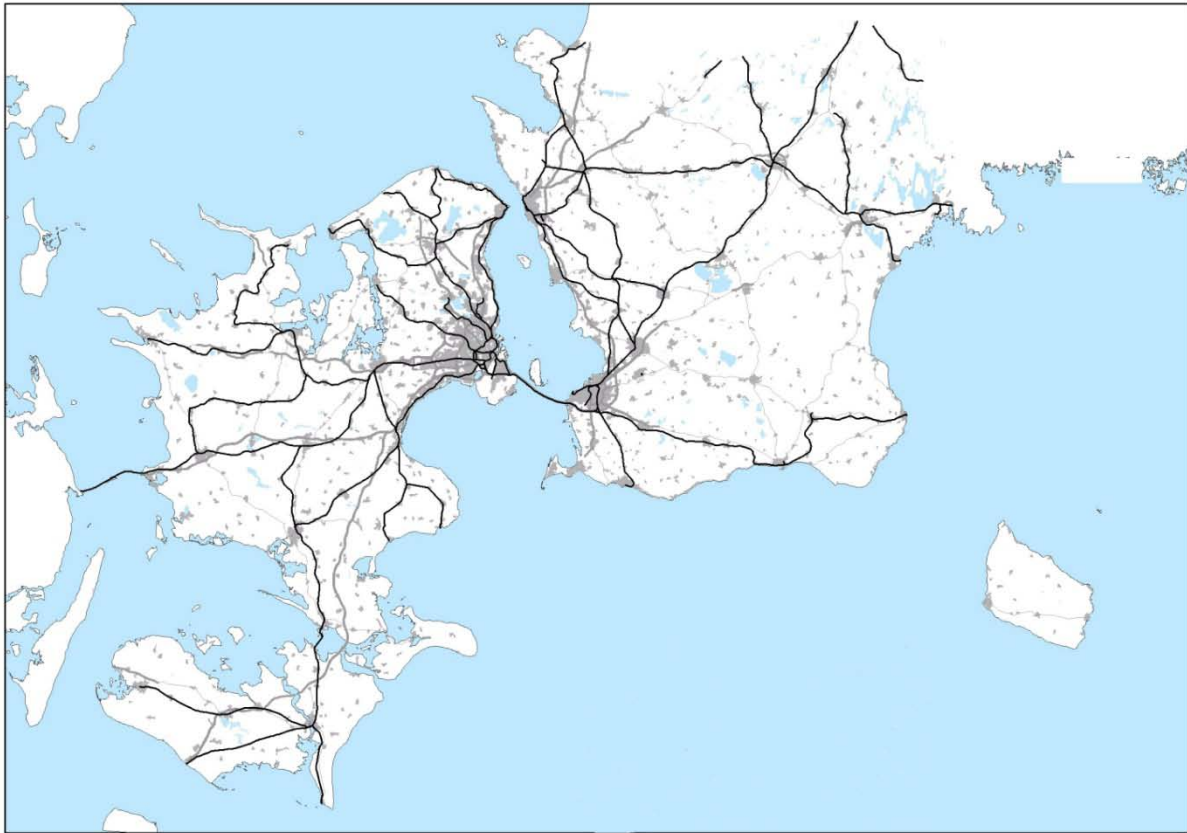

Figure 1 The cross-border region Öresund

The European Union (EU) has stressed the importance of sustainable growth (Lisbon strategy) while simultaneously striving for the decoupling of economic growth and transport increase, and - placing users at the heart of transport policy - unblocking congested parts of the urban transport networks.

This is a challenging task which requires sustainable urban development which not only improves the quality of life and strengthens the economic development but that simultaneously improves the service quality of the transport system (Andersson, 2007). However, the complexity of systems and goals which affect and shape future land use and transport structures constitute a considerable difficulty for decision-makers at al levels, in the public as well as the private sector. In addition, the effects and results of large infrastructure investments and other significant changes to land use and transport structures are often based on complex system analyses and mathematically derived formulas which are only understood by experts. These traditional tools for planning seldom spur creative dialogue among stakeholders. In cross-border regions like Öresund, the difficulties facing decision-makers are even more demanding due to shortage of joint planning tools and institutions on which alternative development scenarios are formulated and long term planning decisions are ultimately based (Andersson, 2007).

The main motive and purpose of Project **VISÖ** - *Visualization of Infrastructure and Sustainable development in Öresund* is therefore to develop ***a coordinated planning tool and methodology*** – from which strategic land use and infrastructure choices and their effects can be better understood, communicated and visualized. Tools and methods will be improved and become more communicative with the help of alternative scenarios based in real facts and pedagogic illustrations (maps and VR-animations) while also - in combination with elaborated, purposeful public dialogues processes - stimulating learning processes and

political discussions about long term sustainable development. The new platform will ultimately enable planning authorities, politicians and affected communities to better understand and shape decisions regarding future land use and transport structures. In the very end the tools and methods developed in VISÖ aims to contribute to the propagation of sustainable urban development in a cross-border regional context. The tools and methods will also provide valuable knowledge of general interest for local municipalities, transport administrations and other actors on local, regional and national level in other metropolitan areas in Sweden and EU.

Project **VISÖ** is a joint Swedish and Danish research collaboration financially supported by EU Interreg IVA. Partners are the Swedish Road Administration, the Danish Road Directorate, the Swedish Rail Administration, Region Hovedstaden, Region Själland and Region Skåne. The project was initiated in November 2008 and will be completed in November 2011.

During 2009 the basic models and tools will be defined and be developed. During 2010 alternative future scenarios in real planning cases will be modelled, visualized and discussed in dialogue form. The planning cases and scenarios will be varied according to the goals pronounced by participating planners, politicians and citizens. Following the public dialogues, the results and impacts of the tools and methods will be summarized and disseminated. Upon completion of the first three years of the research project (financed in part by EU under Interreg IV) it is expected that the cross-national collaborative partnership will continue and that the use, development and maintenance of the shared tools and methods will be carried forward within the participating organizations.

The conclusions in this paper are based on the authors' observations from being involved in the project work so far.

2. The need for improved tools

Since the 1960's, transportation planning has been dominated by tools firmly rooted in a scientific ideal where reality is regarded as objective and external to the observer, and our knowledge based on unbiased observations of this reality. Tools such as modeling and forecasting of transport flows, impact assessments and economic evaluation of infrastructure investments have remained supreme for more than half a century. The role of the transport planner has been predominantly technocratic. "Modification has taken place, but there has been no fundamental reassessment of the basic structure of the transport planning approach which is still consensus seeking and prescriptive" (Banister, 2002).
Despite the dominant role of the traditional tools, it is well known to most transport planners that political decision-makers often make priorities based on quite other considerations. "There is tension between the formal process of planning based on scientific, instrumental rationality and the day-to-day reality of political bargaining and gamesmanship" (Wilson, 2001). This observation, in combination with new trends within the social sciences, has led to reorientations within planning theory in the past decade. Rather than objectivity, subjective aspects of planning such as language and discourse have been in focus. Rationality, according to this perspective, is not a matter of technical and mathematical methods alone, but through involving all relevant actors in dialogue. To foster such dialogues requires an own set of tools. "Collaborative dialogue on a large scale requires skills, training and adherence to a set of practices that run counter to the norms of discussion to which many people are accustomed" (Innes and Booher, 2003)

Neither the traditional tools, nor the dialogue tools that emerged more recently, are suited to solve all planning situations. In cross-border regions such as the Öresund this is obvious.

Öresund has for centuries been an important border between Denmark and Sweden. After periods of war and conflict in the 17th century, the sound was turned into a national boundary where the water came to separate rather than to unite. At the end of the 19th and early early 20th century things started to change as ideas on bridging the sound with a fixed link appeared on the political agenda. In the 1960s this and other ideas for integrating the region took more concrete forms and in the late 20th century the Swedish and

Danish states agreed on actually building a fixed link (Berg and Löfgren, 2000). In 2000 the combined road and railway bridge and tunnel linking Copenhagen and Malmö was opened for traffic, a piece of infrastructure with enormous practical as well as symbolic importance for integrating the region. Today, Öresund is the most spectacular of all inter-regional collaborative projects in the Nordic countries. "Here, and at an ever accelerating pace, an advanced and unique Scandinavian attempt to build a transnational region is underway – a region able to hold its own in the new knowledge-economy and compete with other successful regions in Europe and the rest of the world, and at the same time establish a feeling of community across a national border that still serves as a cultural, political, administrative, economic and social dividing line […] (Jerneck, 2007).

Despite continuous efforts to integration in Öresund, planning of infrastructure is still dominated by two different national institutional frameworks and policies. As noted by OECD: "No single common body has the explicit legal or administrative authority to co-ordinate and implement joint development strategies in the Öresund Region, and there is no prospect of merging the two authorities or of a process towards this objective. The governance framework of Öresund, as a result, must be adapted to the idiosyncrasies of a cross-border region. This requires different governance mechanisms than those within a uniform national background. Cross-border integration is thus "governance without government", which has a number of implications for scope and limits of development and cohesion objectives of the region" (OECD, 2003).

Thus, cross-border planning in Öresund takes place in an institutional context that lacks the democratic legitimacy of a national system. Instead, planning is often based on informal arrangements manifested in networks that often involve various public as well as private actors on both sides of the sound. A substantial amount of cross-border planning activities, including the VISÖ project, has been carried out with funding from the EU Interreg-programs. An important actor in these programs, as well as for the overall political cooperation on regional and local levels, is the Öresund committee that was founded in 1993 and consists of regions and municipalities in the region. At the national level, cooperation mostly takes place within bilateral agreements between the two governments or between state agencies. A reasonable guess is that the institutional framework for planning and decision-making in the Öresund region also in the future will be flat and highly fragmentary (Jerneck 2007). The political organizations will have to continue to combine formal agreements and institutions with informal ones (ibid).

Cultural differences are also a challenge for joint planning in the Öresund region. Scholars have e.g. noted that the relationship between politicians and civil servants are rather different in the two countries. In Denmark, where the number of politicians is fewer, preparations of important political issues are delegated to experts. In Sweden the border between politicians and civil servants are less clear and the politicians are used to intervene more in the preparatory phases of the decision-making process (Jerneck 2007). Negotiation style is another often highlighted aspect when cultural differences between the two countries are discussed. Swedes are in general regarded to be more consensus-seeking and conflict-avoiding than Danes (ibid). As a consequence: "Swedish representatives from politics, public administration and industry often express a feeling of being cheated by the more flexible and ingenious Danes" (translated from Jerneck 2007)

Planning tools that help overcome these differences and that enable participants to get involved in dialogues can greatly contribute to and improve the decision-making process in the type of highly complex environment that cross-border regions such as Öresund face.

With the theoretical and empirical observations presented above as points of departure, we have drawn a number of overall conclusions for developing the planning tools and methods within the VISÖ-project.

First, we believe that the traditional planning tools and communicative tools can and should be combined. A dialogue can only be constructive if it is based on some sort of knowledge about the case that is being planned, as being promoted by the traditional perspective. A vast number of parameters can be handled

with the traditional tools. However, the complexity inherent in most planning cannot be handled by the traditional tools alone. Many issues must be solved by communicative tools engaging all relevant actors in dialogue. This is especially important in cross-border regions that lack a clear institutional framework for planning and decision-making, and where many actors from different levels must be actively involved.

Second, a planning tool that aims to be legitimate among actors from different countries with different cultures, traditions and planning styles, should be highly transparent so that the people and participants involved knows what the assumptions are.

Third, the planning tool should be flexible enough to allow the participants in a planning dialogue to change define and influence important parameters and see the impacts of different scenarios with variable parameters.

3. Models, methods and output

The tools and methods created and combined in the VISÖ-project consists of three components; an integrated land use and transportation model; a visualization model (VR application); and a dialogue process. Combined, the models, dialogue and presentation tools enable the effects and implications of various development scenarios to be more easily calculated, distilled and presented in a legible way and thus, ultimately, better understood.
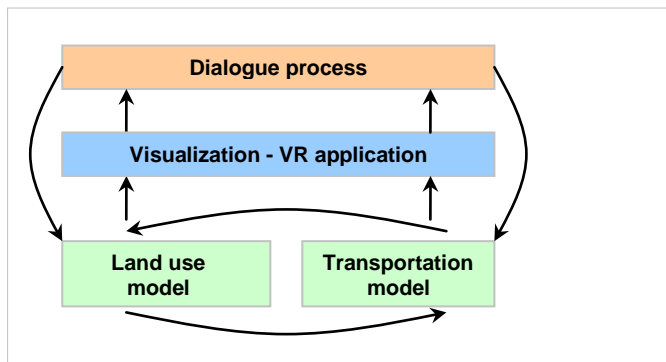

Figure 2 Combined tools and methods

3.1 Integrated land use and transportation model

The integrated land use and transportation model consist of a land use model (LuSIM) that calculates and shows future demand for housing and workplace and a transportation model (LuTRANS) that calculates and shows preferred travel mode, choice of transportation and travel times. The model is divided into traffic zones which are determined geographically by the concentration of workplaces, housing, shopping centers etc. as well as other points of interest that influence and create travel patterns. The traffic zones therefore vary geographically in size but generally have the same travel time and homogeneity in population density. (Alström, Berglund, 2007). Figure 3 illustrates how the models interact and work together i.e. how the out data from one model is in data for the other model and vice versa.
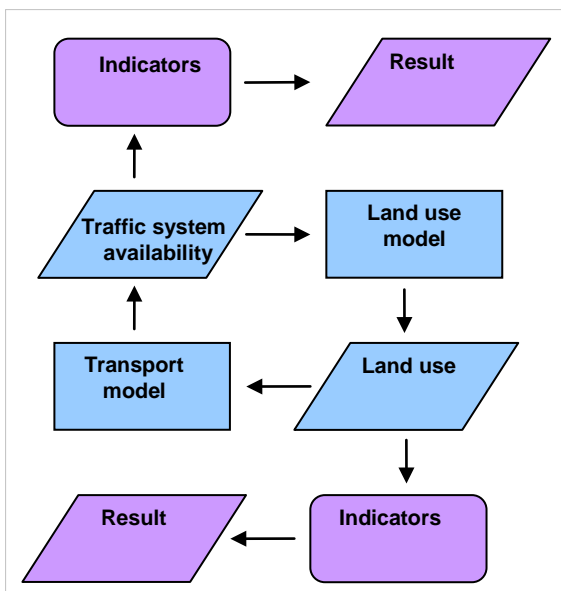
Figure 3 Integrated land use (LuSIM) and transportation model (LuTRANS)

Based on a number of indicators including demographic and economic development, existing land use, existing population, employment, as well as assumptions about behavior preferences, the transport model estimates the availability for different land uses within each traffic zone. From this dataset, the land use model is run over a preset time period showing the incremental changes in land use and population structure. At the end of each time interval, the resulting land use, the new population structure and new economic data is used in the transportation model. This generates a new set of traffic data and accessibility which is added to the land use model. This is repeated until the desired final year of the forecast has been reached. Output from the combined models is thus land use, population distribution, traffic data and accessibility. From this data, calculated indicators and the effects of for example the qualities of resulting building patterns can be evaluated and presented. The whole procedure can then be repeated with different assumptions concerning, for example, population growth, economic development or behaviour preferences. Naturally, the results are not to be seen as an absolute forecast of what the future will appear, but rather a description of the possible outcomes based on the specific conditions and the applied parameters and values. (Alström, Berglund, 2007)

3.2 Presenting model output – VR application

The next step is to present the different scenarios and outcomes from the combined land use and transportation model. The goal is to develop a VR application with custom functionality that can provide active and educational support in the process of evaluation and discussing the future development scenarios and its implications in various public dialogue processes. In the VR application the abstract calculation results from the combined land use and transportation model can be shown dynamically along with the current topography of the various future time points. This means that major regional areas as well as small local areas can be visualized in real time and with high resolution. Realistic 3D images that can handle a larger number of variables simultaneously and movies with interactive real-time application – rather than numerical models - have enormous pedagogical opportunities allowing proposed development, infrastructure and even new building projects to be presented in a much more intuitive way and with a common big "picture" overview. This will in turn allow both experts as well as the public to more quickly familiarize themselves with a problem or development scenario on equal footing and enable a much more objective and transparent debate and discussion of the proposed action. (Tullberg, Connell 2007)

Figure 4 VR-Application- example illustration

The VR model is built up of a terrain model and aerial photo or a (prepared GIS) map.
Terrain Data in the form of point files (xyz) or in the form of CAD drawings (dwg / dgn) creates our three-dimensional world. The VR platform will be based on Open Source allowing free use and distribution during the project development. All VR objects that will be generated will be used in any other VR application based on OpenSceneGraph. To view the land use distribution and resulting traffic intensity and patterns, standards for various housing and neighborhood formation as well as for traffic system will be created. EIS/GIS data that currently exist in the GIS system wihin the region in the so-called shp format can also be visualized together with the new data. (Tullberg, Connell 2007)

3.3 Dialogue process

Once the scenarios have been generated in the combined land use and transportation model and the results visualized in the VR application, the outcomes will be presented, interpreted and discussed in a series of public dialogues. A dialogue is one of several methods of communication between central and local governments, regional institutions, builders, constructors and citizens. The aim is that knowledge (instead of information) can be dispersed to all actors involved and different viewpoints can be discovered early in a project to make it possible to find new and alternative solutions. Some of advantages of using a dialogue as a method in planning are that a dialogue or dialogue process helps actors finding new and creative solutions, helps create better understanding which helps avoid conflicts and creates a positive time-aspect and helps in setting the stage for a broader, more democratic local involvement and support. (Broberg, 2006)

Figure 5 Participants engaged in a dialogue process

As part of VISÖ several different dialogue methods will be tested and developed in connection with real, ongoing planning issues and cases in the cross-border region. The planning cases and alternative scenarios to be modelled and visualized will be varied according to goals pronounced by the actors, politicians and citizens participating in the public dialogues. (Andersson, 2007)

4. The results so far

One of the most immediate results so far is the strong interest in the project not only internally among the collaborating partners but also outside the partnership. The need for the kind of tools and methods developed in VISÖ is apparent and evident and the interest in participating in the development and in its future use and applicability noticeable/pronounced.

4.1 Integrated land use and transportation model

Traditionally, land use and traffic models were not connected, despite the knowledge that there is a strong link between the residences and workplaces location and traffic flows. VISÖ's land use and traffic model is highly integrated, which means the interaction between the location of building development and infrastructure can be modeled. The results of the combined land use and transportation model so far are very encouraging. The coordination between the different national model standards and data systems is forward and the model test runs are now able to calculate and produce scenarios in 1 to 1,5 hours. This is a significant improvement over current models which will enable scenarios to be produced in real time in a dialogue process. Traffic model calculates personal travel every five years between 2005 and the desired final year (usually 2030). Between each run of the traffic model of localized injection of homes and workplaces on the basis of assumptions on the location principles and the availability projected in the traffic model. In this way, ladders, the model automatically to the desired ends. It is also possible to set a shorter or longer time steps between the traffic model runs. Both models work with a zoning which means that the results can be reported at about 1400 zones for the Öresund region.

4.2 Presenting model output – VR application

The VR-application is based on Open VR from WSP, which in turn is based on an open source project, OpenSceneGraph (www.openscenegraph.net). This means that the project has full control on how the VR application can be used and to whom it may spread. It is a unique VR model in terms of its size in the data set and the possibility of using high-resolution aerial photography and terrain models - working on a modern PC.

We are designing a VR application that can visualize the projects in process data. Calculation results are visualized in a clear manner in the form of zone data and link data, such as change in the number of jobs in a zone or change in volume, public transport, a roadlink. The data can be of a dynamic form, ie. change over such a 30-year period, depending on various infrastructure initiatives. It is possible to visualize digital maps and aerial photography of urban areas where these are available. Settlements will be presented with schematic 3-D volumes. GIS information in the form of shapefiles (ESRI) and arbitrary 3D objects can be used in the model.

The VR application has overcome two major obstacles. First it has been possible to collect and handle maps of the entire region into one application. Secondly, the VR-application has successfully been able to link, connect and show calculations and results from the combined land use and transportation model.
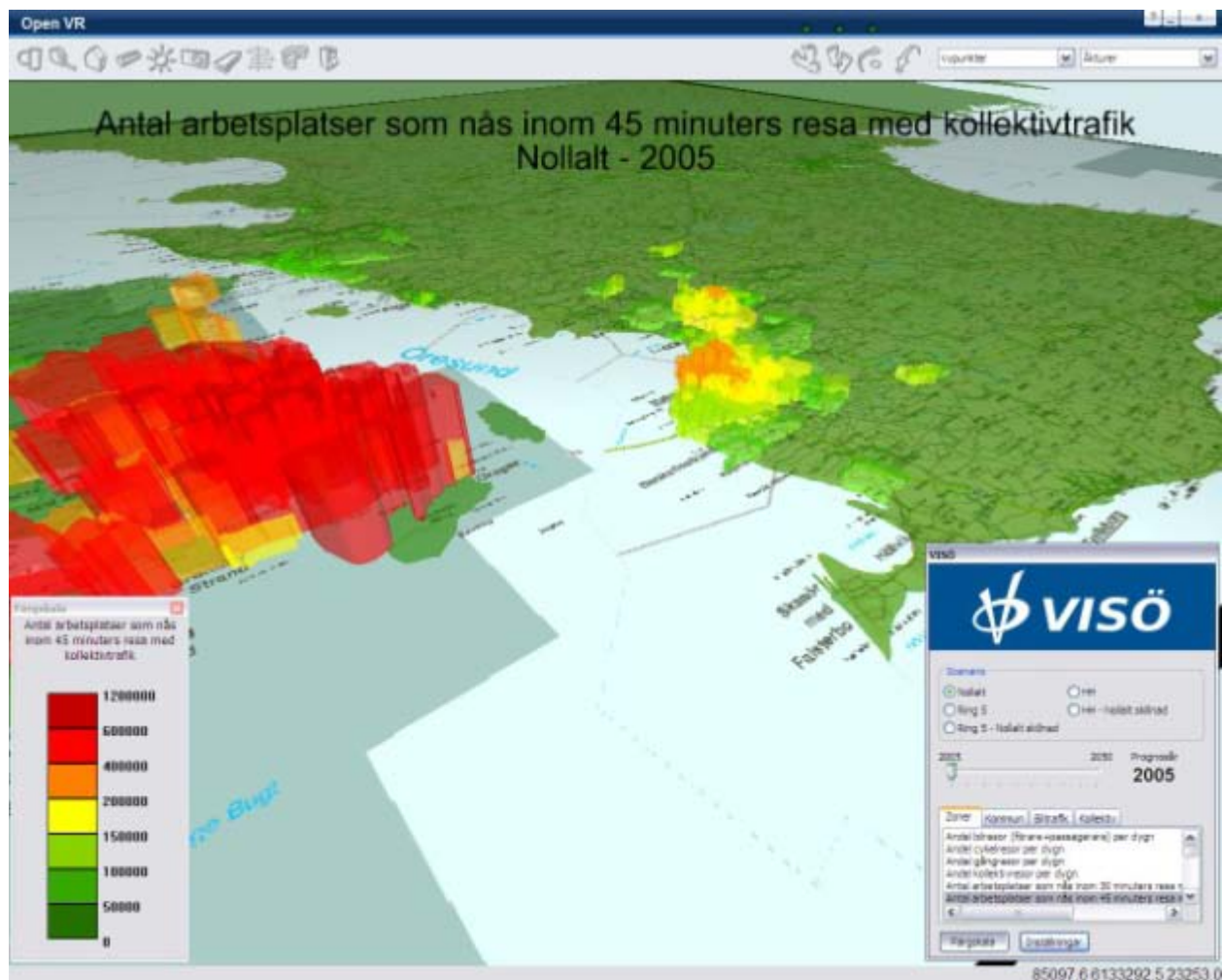

Figure 6 VISÖ tool.

One of the biggest challenges, namely obtaining data, maps for use in the land use and transportation model as well as the VR-application has been manageable with the caveat that it data and maps have come from a number of different sources, often in different, incongruent formats. However, this lack of synchronized and congruent data, maps and information is an important motive and reason for the project

and only underscores the need for creating a cohesive set of data within the cross-border region. Longer-term, after the completion of the initial development project, costs and legal rights to all data and information in the models as well as relevant licenses will need to be addressed and resolved along with a plan for the ongoing maintenance and update to both models and VR-application.

4.3 Dialogue process

With regards to the dialogues processes, a couple of important findings have been made. First of all the dialogues must be tied to real and current planning issues and cases in the region. Secondly the participants should represent a broad spectrum of politicians, planners and citizens.

There are different dialogue methodology. Choice of method depends on the scope of influence and the degree to which a plan or a decision is finalized. Exactly how a dialogue should be carried out with the new tools that VISO created is not ready to report. The demonstrations of the tool carried out shows that the dialogue format may need to significantly change as compared to traditional dialogue and consultation procedures as currently implemented.

4.4 Testing VISÖ - case HH connection / Ring 5

The initial planning case has been focusing on one the current major infrastructure projects discussed in the region today, namely the potential future fixed connection between Helsingborg in Sweden and Helsingör in Denmark – also known as the HH connection/Ring5. Just like the Öresund's bridge and the planned Femern connection (between Denmark and Germany) an additional fixed connection between Denmark and Sweden would have significant implications for the future development and traffic patterns in the cross border region and is a such an excellent test case for the VISÖ tool. Furthermore, the fact that a number of alternative combinations and connections are being discussed, several alternative development scenarios – without preconceived results and biases - can be tested in the dialogues process. Finally, as a potential future HH/Ring 5 connection is already actively being discussed in different forums VISÖ will be able to leverage, engage and attract interest in participation from both citizens associations, regional planning authorities, political and non-political organizations and obtain both broad participation and representation.

A first internal test was done in the previous period March 18, 2010 for steering and working group. Based on the experience which was obtained, further improvement and further development. These were conducted in two stages. First conducted a meeting of 25 August 2010 with experts and then conducted a meeting with senior officials on 15 September 2010. Both these meetings were conducted in collaboration with the IBU project.

Meeting August 25, 2010 with model experts were part of quality assurance VISÖ traffic and land model. The experts gave the meeting VISÖ model good reviews and the results VISÖ traffic and land model created situated close to other models' results with similar conditions.

Meeting September 15, 2010 was conducted by elements of VISÖ and IBU steering and working group at present. The meeting extended in time in connection with an IBU meeting so a good mix of different people could participate and give their views. The meeting gave a positive response to the VISÖ model output, but one wishes that visualization effects for 25 different indicators further developed.

After the meeting, September 15, 2010 as a survey was sent to all participants and stakeholders in VISÖ. The survey aimed to collect both positive and less positive experiences of development around the VISÖ so far. The compilation of the experience must be described as generally positive and can be summarized as follows:
- VISÖ is now a fully functioning model / process visualization capabilities at different scales
- VISÖ would benefit from some additional development. ...
  - Improve the interface
  - Improve the dialogue approach

- ... through a few more test dialogues
- VISÖ is - through open source technology - possible to move to other cities and regions for a relatively small cost

5. Conclusions

VISÖ creates the opportunity for a new coordinated process. The new process includes three interacting components

• A coordinated land use and traffic model with the common assessment methods and consistent basis.

• A 3-D tool that presents the calculation results over the entire region. Alternative infrastructure solutions can be quickly analyzed by lighting and extinguishing data warehouse. The new process can also include the individual municipalities' own planning in the form of their own GIS data or 3D objects to link the local analysis with comprehensive infrastructural calculations.

• A joint process of communication in dialogue form. Through access to a common visual tool, the dialogue between all parties to be simplified and all can participate in the dialogue.

Future work is focused mainly to developing further the dialogue format to get an effective dialogue between stakeholders with different backgrounds and skills. Furthermore, additional work needs to focus on further developing the design / form of visualizing the effects of 25 different indicators.

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