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User interaction during the development of the Waikato Integrated Scenario Explorer

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Abstract: The importance of user interaction for the design and development of Decision Support Systems is widely accepted in literature. How this interaction could best take place is however not yet common knowledge and examples of user involvement in the development of Decision Support Systems targeted at environmental policy and sustainable development are scarce. This paper provides a practical example of user involvement during the design, development and implementation of WISE, an Integrated Spatial Decision Support System for planning and policy support for the Waikato region in New Zealand. Focus will be on the process of user involvement during various development phases, the way feedback was collected and handled, and on the changes in the system this resulted in. We conclude that user interaction has had clear implications on the larger design choices as well as the details of the system development and that this interaction had impacts on choices related to the usefulness and the usability. The effort from the user organisation has been substantial and has increased over the duration of the project. The role of champions has been found indispensible in involving users and enhancing the system. The current implementation phase will show if these efforts will also lead to an effective implementation and easy adoption of WISE by the user organisation.

Keywords: Integrated Spatial Decision Support System; Policy Support; Integrated planning; User involvement; Design and development process.

1. INTRODUCTION

The Creating Futures project is developing decision support and process management tools for use in policy development (Huser et al., 2009). These tools are aimed at improving decision making outcomes through more informed consultation and evaluation of future strategy and trade-off choices. One of the tools developed is an Integrated Spatial Decision Support System (ISDSS) named WISE: Waikato Integrated Scenario Explorer. WISE aims to support long-term integrated policy development and planning in the Waikato region in New Zealand by taking into account cultural, social, environmental and economic well-being (Rutledge et al., 2008; Huser et al., 2009). WISE is intended to be used within the context of a deliberation that allows for end users to evaluate their policy options against a range of pre determined values and associated indicators (Wedderburn et al, 2009).

WISE consists of a spatially explicit systems model operating at four scales: global, regional, district and local (200 m grid cells). The temporal resolution is one year and its horizon is set at 2050. In the development of WISE there has been a strong emphasis on the linkage and feedback loops between the different components (e.g. climate, hydrology, water quality, ecological economics, population, land use and biodiversity), rather than on
modelling all elements with the highest detail possible. Drivers for the integrated model are climate change scenarios, socio-economic drivers (e.g. fertility, mortality and migration rates, exports and consumption patterns), and policy alternatives (zoning regulations, impact restrictions and construction of infrastructure).

WISE is developed as part of a research project with a duration of four years. The project is led by the system’s intended end-user Environment Waikato, the regional council of the Waikato region and includes frequent interaction with potential users throughout the whole project. The importance of user involvement in the design, development and implementation of innovative products such as WISE is widely mentioned in literature and is assumed to have a positive impact on the system quality, decrease resistance to change and increase their adoption (Lucas, 1974, Keen and Gerson, 1977, Allen and Hauptman 1990). Nevertheless, the financial and cognitive costs associated with user interaction should not be ignored and therefore the appropriate amount of user involvement for a given project should be carefully evaluated (Gales and Mansour-Cole, 1995; Van Delden et al, in press).

This paper describes the user interaction carried out during the design, development and implementation of WISE. After an overview of the various tasks, project phases and ways of user involvement, we describe the results of this interaction. We focus on the way feedback was collected and handled, and on the changes in the system this resulted in. Finally, we conclude with some lessons learnt and recommendations for user interaction in future design and development processes.

2. DESIGN AND DEVELOPMENT PROCESS

WISE is being developed in an iterative and interactive development process, meaning that there is a continuous interaction between all parties involved: the intended users of the system, the scientists and the IT-specialists (Figure 1) (Van Delden et al., in press). Each party brings to the process its own background and understanding and has its own tasks and responsibilities. **End-users** provide the policy context and define the problems, functions and usage of WISE. **Scientists** are responsible for the main model processes and choices of scale, resolution and level of detail. **IT-specialists** design the system architecture and carry out the software implementation of the models and user interface. Several decisions are made in a group processes in which one party takes the lead: Scientists, together with end-users and IT-specialists, are building effective linkages between the individual models and end-users together with IT-specialists and scientists decide on relevant component to include in the user interface.

![Figure 1: Main parties, responsibilities and integration issues during the development of a DSS](image-url)
The interaction between the three groups involved is as important for the quality of the final product as the tasks carried out by each group individually. This interaction enables social learning between all involved, which is crucial for the development of a useful and user-friendly DSS. The architect has an important role in bringing all groups together, creating mutual understanding and respect and keeping the focus on the final product throughout all phases of the project. In various iterations, the system evolves through a scoping phase and a number of prototypes into a final product (Figure 2).

Tasks that can be distinguished during this design and development process are:

1. Scoping
2. Model selection
3. Model integration
4. Bridging the science – policy gap
5. Development of a user friendly interface
6. Implementation
7. Use and maintenance
8. Evaluation

The first five tasks are part of the design and development process; tasks six and seven follow afterwards, but are included because they have major implications on choices made during the design and development process. It should be noted that these seven tasks need not (and often cannot) be executed in a sequential order. After each of the tasks 1 to 7 an evaluation needs to be carried out to assess what adaptations to previous tasks can be made.

The entire process can roughly be divided in a scoping phase, the development of a series of prototypes and the implementation of the system in the user organisation. User interaction was focused on both the usefulness and the usability of the system and took place during all this phases in various forms. User interaction was strengthened by the user organisation (Environment Waikato) leading the project and hence strongly involved in all phases of the process.

Users were also represented on the project team, which consisted of about 10 people (scientists and IT specialists). Two core user representatives or champions were involved: a project manager responsible for innovation projects with a wide network within and outside Environment Waikato and an environmental officer responsible for data management and with a wide experience in geographic information systems. These two people were, as project leader and technical support person, continuously involved in the project and were able to devote between 20-40% of their time on this project. Their input and feedback was provided on an ad-hoc basis, either upon their own initiative or based on feedback requests from developers on design options or draft deliverables.

On an annual basis workshops were organised with a second group of users, a team of policy analysts from Environment Waikato. In-between these workshops ad hoc interaction between the core users and this user group has taken place. For a better understanding of the policy practice and the way WISE could contribute to this, a consultant was hired who carried out in-depth interviews with this user group. The aim of the interaction with this group was to ensure the usefulness of the system for the policy practice of Environment Waikato. To ensure relevance of the system’s approach for other organisations and facilitate the application of WISE outside the Waikato region after the project is finished, interactions have not only taken place with (potential) users within the Waikato region, but also with (potential) users from other geographical areas. At the end of each workshop session a discussion was organised on the usefulness and usability of the system and users were asked to provide their feedback through a questionnaire. For high level managers and elected councillors from Environment Waikato annual presentations were organised to
inform them on progress and to receive their feedback on the overall concept and deliverables.

3. USER FEEDBACK AND SYSTEM ENHANCEMENT

The sections below provide details of the user interaction in each phase together with an overview of the main results.

3.1 Scoping: organization, policy context and WISE functions

The scoping phase of WISE had already started during the development of the proposal of the Creating Futures project. Two research organisations, Landcare Research and AgResearch, started a joint initiative with Environment Waikato to explore end-user needs and scope a potential proposal, before applying for funding to develop decision support tools for long term integrated planning. During this phase conceptual decisions on WISE were already made, mainly those related to the important processes that should be covered by such a system, because this was the starting point to invite additional partners to join the proposal. Selected disciplines for the WISE ISDSS were demographics, ecological-economics, climate, hydrology, water quality, land use and biodiversity.

An important task during the scoping phase is to create a common knowledge base amongst the various parties involved. In the development of WISE this meant that from the early stages of the process user interaction took place by showing similar systems applied to different regions during workshop sessions, allowing users to get an initial understanding of the possibilities, capabilities and limitations of such systems and to enable them to give input into its further development: issues it should provide support to; external factors, policy options and indicators to be included and its overall look and feel.

This common knowledge base is not just related to the system, but also to the policy context. To link WISE to the policy practice, an overview was made of current policy and planning documents as well as internal and external policy processes Environment Waikato is involved in. The processes taken into account included those processes directed by legislation, mainly the Local Government Act 2002 (Long Term Plans) (www.legislation.govt.nz) and the Resource Management Act 1991 (Regional Policy Statement, Regional Plan, Regional Coastal Plan and District Plan) (www.mfe.govt.nz/rma). Applying WISE for non-statutory planning processes was also considered, e.g. the FutureProof growth strategy (www.futureproof.org.nz).

Midway through developing WISE the project team recognised a need to better understand the policy process used by the regional council (Environment Waikato) in order to optimize the use of WISE for council’s current policy practice. Interviews were held with a range of Environment Waikato staff to determine how policy planning has been undertaken within the organization and what role WISE could play in contributing to this process. An overview of these policy processes is described in Fenton (2010). A main conclusion from this analysis was that the way WISE could be used depends on the policy process, the other tools being used and timing and resourcing available. WISE potentially offers an improved method of issue identification, consultation and policy selection and evaluation, which involves a robust process of deliberation around the consequences and trade-offs of different policy options. Consequently the use of these tools may require Environment Waikato staff to work in a way that is different from their current ‘planning paradigm’.

As part of the scoping phase the decision was also made to have a system for strategic thinking and long-term integrated planning that could be used for policy impact assessment and scenario development in workshop sessions. This resulted in a selection of rather simple process models - to limit the execution time for a simulation run to several minutes - and a focus on dynamic feedback loops between model components. An example of the latter is the link between the economic and the land use model: the economic model is an important driver for land use change in providing land use demand for a range of economic activities, which are subsequently allocated on a grid by the land use model. Only suitable and available locations are taken into account during this allocation. When not all demands
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can be met the final allocation is fed back to the economic model, which results in a smaller economic growth as would be calculated without resource restrictions.

Finally decisions were made on the user interface. It was decided that the user interface should cater for two types of users: the policy analyst, interested in carrying out scenario and impact assessment studies and the modeller wishing to update data and calibration parameters.

3.2 1st prototype: what can be expected?

The first WISE prototype included the general lay-out of the dual user interface that contained a section for policy users, structured towards a policy impact assessment study and a section for modellers, with access to all underlying data and parameters. In this version only two models were included: the land use change model and the ecological economic model.

In a series of 1-day workshop sessions, the concepts of the first prototype were presented and the system demonstrated to a wide group of (potential) users within and outside of Environment Waikato. Groups outside of Environment Waikato included other regional councils, district councils and national government bodies. The concepts of the entire system were presented in a morning session which was targeted to a wide group of potential users from various hierarchies in the organisations (ranging from technicians to councillors) and a demonstration was offered in an afternoon session which was targeted towards a more technical audience. The system was installed on various laptops and participants were offered a first hands-on experience by following a demonstration that was done on a larger screen. Each session was concluded with a discussion on the usefulness and usability of the system and participants were asked to fill in a questionnaire whenever they left the workshop. This questionnaire included a number of multiple choice questions and a number of open questions. Results of these questionnaires are summarized in Table 1.

Table 1: Results from the questionnaires filled in at the end of the workshops in which the first and second prototype of WISE were presented, discussed and evaluated. After the first series of workshops 32 questionnaires were returned, after the second workshop 24.

<table>
<thead>
<tr>
<th>QUESTION</th>
<th>WORKSHOP WITH FIRST PROTOTYPE</th>
<th>WORKSHOP WITH SECOND PROTOTYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>My organisation would benefit from using Waikato ISDSS</td>
<td>Agree 26 Disagree 3</td>
<td>Agree 21 Disagree 2</td>
</tr>
<tr>
<td>Waikato ISDSS enables communication among planners and decision-makers</td>
<td>Agree 29 Disagree 0</td>
<td>Agree 24 Disagree 0</td>
</tr>
<tr>
<td>Waikato ISDSS is an easy to use and intuitive tool.</td>
<td>Agree 17 Disagree 5</td>
<td>Agree 19 Disagree 5</td>
</tr>
<tr>
<td>I have the impression that in order to use Waikato ISDSS, I need a lot of specific knowledge.</td>
<td>Agree 21 Disagree 11</td>
<td>Agree 17 Disagree 7</td>
</tr>
<tr>
<td>I think learning to use Waikato ISDSS is worthwhile, considering the results I can obtain.</td>
<td>Agree 27 Disagree 0</td>
<td>Agree 20 Disagree 1</td>
</tr>
<tr>
<td>I would prefer a simpler tool (with less functions), even if that means little control on the variables.</td>
<td>Agree 6 Disagree 19</td>
<td>Agree 6 Disagree 15</td>
</tr>
<tr>
<td>I would prefer a more complex tool (with more functions), even if that requires more parameters to deal with.</td>
<td>Agree 9 Disagree 13</td>
<td>Agree 8 Disagree 15</td>
</tr>
</tbody>
</table>
Questionnaire results show that after presenting the first prototype, users were generally positive about the usefulness and usability of WISE and that the chosen complexity seemed to be selected well for the majority of the participants. Most users agreed with the chosen level of complexity, although some would have preferred a more or less complex system. Opinions differed most in the knowledge required to use WISE. The questionnaire results from Table 1 together with the answer on the open questions were put on the project website together with a question and answer document (www.creatingfutures.org.nz/further-resources) to share knowledge between participants from different workshops. Most participants indicated that it was too early to give any suggestions for improvement and that they needed more time with the system before giving specific recommendations.

Besides a few minor adaptations to the user interface not many direct enhancements to the system were made based on this series of workshops. These workshops did however trigger a number of relevant discussions on the inclusion of policy measures in WISE, the operation of the system in an organisation and its relevance at district and/or national level.

### 3.3 2nd WISE prototype: what needs improving?

The second prototype included the final set of models to be incorporated in WISE as part of the Creating Futures project. Before presenting this system to the wider user groups, one of the core users and a small group of developers spent two weeks together to evaluate the system’s behaviour and to test its user-friendliness. During this interaction data and parameters were updated and model connections and user interface elements improved. This intensive collaborative effort between a user who is familiar with the system and the developers, proved very beneficial in better tuning the system to the actual planning process and information required as part of such a process.

During the development of the second prototype, several case studies were selected that are highly relevant for Environment Waikato and to which WISE could provide an added value: the Regional Policy Statement (statutory), the Future Proof growth strategy (non-statutory) and a set of narrative future scenarios for the Waikato region that were developed as part of the Creating Futures project (www.creatingfutures.org.nz/scenarios). For each of these cases the crucial elements were identified (e.g. urban sprawl, immigration, water quality, protection of natural areas or high quality soils, discussing trade-offs between economy and environment) and case studies and exercises were developed that show how WISE can provide support for exploring these issues.

In a second series of workshops the second prototype was presented and discussed. These workshops were organised in the form of an initial presentation and a set of practical training exercises in a tutorial booklet. Each session was concluded with a discussion on the usefulness and usability of the system and participants were asked to fill in a questionnaire whenever they left the workshop.

Results of these questionnaires are summarized in Table 1. These results are very much in line with the results after the first series of workshops. A main difference was found in the open questions and discussion. After the hands-on training exercises participants felt more familiar with the system and therefore were better able to pinpoint benefits and possibilities for improvement. This resulted among others in a more flexible way on including spatial planning, improved ideas for indicator development and suggestions for additional case studies related to current policy issues at Environment Waikato.

Main expected benefit of WISE that were mentioned by the various user groups, and in particularly those from Environment Waikato, are the ability to:

- explore “what if” scenarios in the development of policy,
- work with district councils in negotiating district and regional policies and rules,
- explore scenarios in public workshops in order for the public to visually “see” options for the region’s future and gain more productive and enthusiastic feedback from them,
• provide support in integrated catchment planning and transport network planning,
• integrate and analyse district policies that vary across adjacent boundaries.

The integrative character of WISE was seen both as a benefit and as a challenge. The complexity created by integrating different sectors includes the interaction between those disciplines and facilitates the assessment of (unwanted) side effects of policies. On the other hand it is crucial that users are able to interpret results and therefore a good understanding of the system is a key to success. It was therefore suggested that a limited number of users would be trained to actually work with the system, while others would learn what type of information the system could provide to them and what type of policy questions it could provide support to.

3.4 Final project version and implementation: are we successful?

At present, work is undertaken to deliver the final version of WISE as part of the Creating Futures project and on implementing the system in Environment Waikato. Foundations for this implementation were placed during the entire development process by carefully deciding for what processes, where in the organisation and by whom the system can best be used and by involving potential future users throughout the development process. Based on feedback from interviews and assessment of the planning processes, a number of barriers to the successful implementation of WISE were identified:

1. Existing planning practice needs to be altered to allow for new tools,
2. Knowledge of WISE needs to be improved with policy staff,
3. Time frames are often under pressure and ‘political expediency’ can drive over good practice,
4. Statutory processes and proposed policies are often legally appealed and hence there is a reluctance to use new and untested tools, approaches or methods,
5. The cost/benefit of a different approach – is there value-add for effort and expenditure?

From this assessment of barriers, it became clear that trialling WISE initially in a non-statutory process rather than in formal legislative processes would be preferable. The non-statutory process would be more focused on a community, an area and its issues. These processes are also more open to idea development and are not burdened by legislative requirements. This should allow for more experiential use of the tools and could therefore improve initial user buy-in.

To limit the time required to train a large group of users in operating the system, it would be beneficial to create an implementation plan and to identify a few more champions, who would – together with the existing champions – apply WISE and:

• improve knowledge about WISE and make WISE useable, credible and supported,
• identify further improvements and modifications to WISE,
• minimise the additional time and resources required to use WISE,
• identifying strategies to change the existing paradigms of approaches to planning and community consultation,
• plan for required technical support for data, training and model set up.

4. CONCLUSIONS AND RECOMMENDATIONS

User involvement during the development of WISE has resulted in a wide-spread knowledge of the tool and an appreciation of its development and enhancements to the system. The latter were especially initiated by those users closest to WISE, the champions. Besides relevant feedback on the behaviour of the system and its user-friendliness, champions also played a crucial role in bridging the gap from the science and developers community to the user organization on a rather detailed system level, thus improving the usefulness of WISE.
Putting innovative spatial concepts in words often proves difficult to both describe and understand. Developing, presenting and discussing various prototypes helps to improve this understanding which results in feedback at rather early stages of the project and builds trust and acceptance for future uptake. Hands-on experience in linking WISE to actual policy issues was valued positively by users and helps to bridge the science – policy gap. Communication channels, both internally and externally, are indispensable in the uptake of a system like WISE, but can easily break down. A project champion who has good face-to-face contact with a wider user group and is dedicated to proactively communicating with them, has proven to be a very good method for overcoming this. Communication and marketing of a project and product requires time, which needs to be budgeted for.

Many potential users do not or cannot place a priority on contributing to projects of innovative tool development due to neither feeling “close” to it, nor having a good understanding of it, or due to heavy workloads and a lack of resources. We suggest that key users need to be identified early on in the project and funding sourced for them so they can contribute in the long term.

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