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Usability assessment of an integrated land use model in Portugal

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Abstract: Regardless the possibilities of computer based tools for spatial planning, previous works have argued that planners have never fully used them. Some of the reasons that influence the acceptance and effective use of a new technology are the usability and the user's perception of its relevance to improve their tasks. This research aims to assess the usability and usefulness of a planning support tool by planning organizations in Portugal. The tool has proven to be easy to use and very useful to users; however, some technical improvements were suggested in order to improve it.

***Keywords*:** integrated planning approach; spatial decision support systems; usefulness; usability.

1. INTRODUCTION

Over the last decades spatial planning has evolved from a process with strong sectoral focus into a multi-disciplinary approach. This has increased the complexity of the spatial planning process and therefore the need for computer based tools to support decision making [Geertman and Stillwell, 2002]. Despite this progress, previous studies have concluded that in fact users consider these new technologies inappropriate for certain practices belonging to the planning process, such as forecasting, analysing and evaluating; and that their use is for the most part too general [Brail and Klosterman, 2001]. Reasons differ from technological to political context characteristics.

This paper focuses on the study of *usefulness* and *usability* of a spatial decision support system developed for the recognition, analysis and communication of problems related to the desertification processes. We believe these two aspects influence the success of a system and are both important to developers and end users. With this we hope to provide suggestions as to how we can improve such system.

This investigation is a case study in the Portuguese context and takes into account *ScenDes [Scenarios for Desertification]*, a spatial decision support system, developed in the scope of the DesertWatch project of the European Space Agency. The guiding questions for this research are:

- Is *ScenDes* useful/relevant for the assessment of desertification in the Portuguese context?
- Is *ScenDes* easy to use by planning technicians in Portugal?
- How can the current system be improved to be more effectively used in Portugal, in combating desertification?

2. CONCEPTUAL FRAMEWORK

2.1 The case of Desertification

More than one hundred formal definitions of desertification are believed to have been proposed so far [Diez-Cebollero and McIntosh, 2005], nevertheless the most cited definition nowadays is the one proposed by UNEP in 1990 and adopted by UNCCD in 1999. In this paper we adopt this same definition in which desertification is "land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors including climatic variations and human activities" [UNCCD, 1999]. Land degradation is the "reduction and loss of the biological and economic productivity caused by land-use change, or by a physical process or a combination of the two" [Geeson *et al*, 2002]. It is considered one of the most alarming processes of environmental degradation and a threat to natural resources with consequences on food security, poverty and environmental and political stability [Sivakumar and Ndiang'ui, 2007].

Desertification is seen as a process, a sequence of casually linked changes. In the opinion of Diez-Cebollero and McIntosh [2005], "desertification might also be understood as a feedback process in which, as a consequence of lower productivity, farmers are forced to abandon infertile areas and exploit new land […]. Abandoned areas become then more prone to biological degradation". Consequently, we agree that desertification does not only affect biophysical processes, but also the socio-economic structure of affected areas.

2.2 Systems analysis for planning support

The problem of desertification, just like many other spatial planning-related problems, is complex and unstructured. By complex, we mean that there are large numbers of actors, factors and relations and phenomena occur at different temporal and spatial scales. By unstructured, we mean that there is uncertainty relative to the knowledge of solving the problem and that involved actors have often conflicting aims. Solutions require the competency of experts from different fields and a high level of public participation and inclusion of heterogeneous sources of knowledge [Voss *et al*, 2004, Sterk, 2007].

As mentioned in the previous paragraph, spatial problems consist of a diversity of elements linked together, interacting strongly. For planners, it's essential to understand how these elements act and react upon each other, to be able to point solutions and think of alternatives. Systems analysis is useful because it enables us to understand problems in its totality and dynamics. It rises above the enormous detail, at the same time it focuses on how individual parts interact with one another [Golley and Bellot, 1999]. The use of computer-animated systems – usually named models – can be very helpful for a systemic analysis. Planners can observe the effects of different actions and scenarios as they get a more logical and organised representation of the elements and their relationships. Decision makers can consequently make use of this capability to experiment policy actions [Grossmann and Bellot, 1999].

2.3 Computer-supported planning tools

Diez-Cebollero and McIntosh [2005] point out that computer models play useful functions in policy and management, mostly because they help to identify and set problems/issues on the political agenda, and help to visualize and explore future alternatives. They also facilitate political consensus and can be used as management tools.

There is different nomenclature to address these planning tools. Hereby we try to distinct and define some of the most common names used in this field.

As for Geertman [2006], he defines planning support as "all professional help in the form of dedicated information, knowledge, and instruments that people actively involved within formal spatial-planning practices can receive to enlighten their planning tasks and activities". In this perspective, planning support instruments refer to "computer-based tools,

dedicated to the support of specific professional spatial-planning tasks such as problem diagnosis, data collection, spatial and trend analysis, geo-data modelling, spatial scenario building, visualization and display, plan formulation, enhancing participation, and collaborative decision making". Planning Support Systems [PSS] can be understood as "geoinformation-technology-based instruments that incorporate a suite of components [theories, data, information, knowledge, methods, tools] which collectively support all or some part of a unique professional planning task". In addition, "these PSS aid the planning process by providing integrated environments […] in which three components are combined: 1] the specification of planning tasks and problems […], 2] the system models and methods that inform the planning process through analysis, prediction and prescription, 3] and the transformation of basic data into information which in turn provides the driving force for modelling and design" [Geertman, 2006].

As for Uran and Janssen [2003], tools that are explicitly designed to provide the user with a decision making environment that enables the analysis of geographical information to be carried out in a flexible manner are named Spatial Decision Support Systems [SDSS]. These are designed to assist the spatial planner with guidance in making land use decisions, and are sometimes referred to as Policy Support Systems [PoSS] [Kok and vanDelden, . The following components are taken in consideration: 1] a database management system, such as a Geographical Information System; 2] a library of potential models that can be used to forecast the possible outcomes of decisions; and 3] an interface to aid the users' interaction with the computer system and to assist in analysis of outcomes [Sprague and Watson, 1996]. It is our believe that both Geertman's Planning Support Systems and Uran and Janssen's Spatial Decision Support Systems are the same category of planning tools. In this paper we will address to *ScenDes* as a Spatial Decision Support System, but we agree that could also be named a Planning Support System, in Geertman's way.

2.4 The *ScenDes* SDSS

The *ScenDes [Scenarios for Desertification*] SDSS is a model that simulates land use change under different scenarios, and is a part of an integrated information system built in the scope of the DesertWatch project. In order to represent the processes that make and change the spatial configuration of the area, *ScenDes* is a layered model representing processes operating at three geographical levels.

At the scale of the entire area [1], the model uses economic, demographic or environmental growth scenarios, prepared by planning agencies or stakeholder groups. From these, growth figures for the global population, the economic activity and the expansion of particular natural land uses are derived and entered in the model as global trends. National growth will not evenly spread over the modelled area due to regional inequalities. Location and relocation of residents and economic activity will thus be influenced by regional characteristics [2]. At the local scale [3] detailed allocation of economic activities and people is modelled by means of a constrained Cellular Automata land use model. In principle, it is the relative attractiveness of a cell, together with local constraints and opportunities, which cause cells to change from one type of land use to another. Four elements determine if a cell is taken in by a particular land use function or not, the local neighbourhood, the accessibility to infrastructure, the physical suitability of the territory and its zoning status [RIKS, 2006].

2.5 Usability and Usefulness

As we mentioned, we consider usability and usefulness key elements for users' acceptance of new software or any other technology. We agree with Kraemer *et al* [1993] that *usefulness* is "the degree to which an individual believes that using computer-based information enhances his or her work". It is the case when users value the generated results higher than the investment [in time, data requirement, etc.]. Nevertheless, we believe that usefulness is not purely perceptual, but can also be measured objectively. Useful software does what it is built to do and actually helps to solve users' problems.

However, any software or technology can be very relevant and useful to users but may not be easy to use [and vice-versa]. *Usability* measures the quality of a users' experience when interacting with the software. In total, if it is easy to use, easy to learn, easy to remember, error tolerant, subjectively pleasing and performs the task for which it is being used. It normally incorporates factors such as design, functionality, structure and information architecture.

We consider both *usefulness* and *usability* important for users, developers and even managers. Taking in consideration that these tools are expected to serve specific user needs, the developers must have these in mind when constructing the product. On the other hand, users must recognize the possibility of solving their needs through such product. From the user perspective, easy-to-use softwares are important because it can make the difference between performing a task accurately or not and enjoying the process or feeling frustrated. From the developer's perspective, it is important because it can mean the difference between the success and failure of a system. And as for managers, software with poor usability can reduce the productivity of the workforce to a level of performance worse than without the system.

Despite the fact that in the past years planners and/or decision makers have used a sufficiently large number of methods and tools to support planning activities, it can be stated that they "have never fully embraced the diversity of the available methods, techniques, and models developed in the research laboratories to analyse spatial problems, to evaluate future options, or to project scenarios" [Geertman, 2006]. Throughout literature many reasons are pointed out as for this disenchantment with decision support technologies. We herewith try to outline those by differentiating problems existing internally in the technologies itself and problems which arise from an external context to the technologies, but may influence planners' opinions.

Table 1. Most common problems

Internal Problems		**External Problems**
Usefulness related	**Usability related**	
A. Planners think models are too *inflexible* to respond to always evolving needs [Walker, 2002]. B. Model outputs were seen as *uncertain* and their appropriateness doubted [Uran and Janssen, 2003]. C. Planners often find tools *irrelevant* regarding their needs [Walker, 2002]. D. Planners not always understood the technologies proposed and *its capabilities and limitations* [Walker, 2002].	A. Models are often considered *too complex*, *too detailed*, *time consuming* and there is *need for training* [Uran and Janssen, 2003]. B. Many tools *do not* fully *meet the original specifications* [Walker, 2002].	A. End-users are often *not involved* in the model development phase, causing wrong purposes [Uran and Janssen, 2003]. B. Planning problems are *wicked*; experts often do not agree about the best solution [Brail and Klosterman, 2001]. C. The rapid change in computer technology, and also in the modelling technology leads to a constant feeling of *computer illiteracy* [Landauer, 1995]. D. Failure in the implementation of such tools is often due to *inaccessibility*, or *lack of confidence* from the decision makers, or *institutional or political barriers* [Walker, 2002].

The identification of problems that we have considered to be related with usefulness and usability motivates us to carry out this research. Although we acknowledge the external problems in Table 1, they are not part of the current research.

3. METHODOLOGY

With the intention of studying the usefulness and usability of *ScenDes*, as well as to understand how we can improve the tool, we have contacted technicians, managers and researchers that are currently working on the theme of desertification in various organizations in Portugal. They have all participated previously in data gathering and field validation for the DesertWatch project, which *ScenDes* is a part of.

With the purpose of assessing the usability of the software we have targeted the technicians and researchers, as they are the ones who use the tools in the practical sense and have to learn its functionalities and requirements. And, in order to understand the usefulness of the software, we have focused on the managers/decision makers, as they are the ones who make the final decision regarding the implementation of the system, based on its relevance in obtaining the organisational goals. However, we have noted that, in less complex-structured organisations, managers/decision makers can also be technicians.

In this research we have performed semi-structured interviews and questionnaires. Also, we have visited the organisations involved and organized a workshop. First, we have booked visits to the organisations in order to meet the users and discuss their tasks and responsibilities in their organisations. In this first phase, we wanted to identify the two target groups. During these visits, we have conducted semi-structured interviews. In a next phase, we wanted to observe users while using the software, therefore we have organised a workshop, in which all users were invited to complete some exercises. During this workshop we were able to identify in which parts of the simulation procedure they had difficulties [meaning functionalities that needed to be further developed] and also, we could directly have their opinions and questions on the performance of certain tasks as well as the data requirements of the system. Finally, in the end of the workshop we have asked users to complete a questionnaire. Questions regarding usability were asked to technicians and researchers; and questions regarding the system's relevance/usefulness were given to managers. We have also included a space for comments, which gave further input to this research.

4. PRELIMINARY RESULTS

We have visited 8 different organizations, which consisted of national administration and regional administration bodies, civil society associations with a local interest and a group of researchers belonging to a public university. In total, we have consulted 22 people.

Tables 2 and 3. Participating Organisations and Use

Organisations:	No.
National scope	2
Regional scope	2
Local scope	3
Research driven	1

Users' position:	No. of People
Only Technicians or Researchers	15
Managers and Technicians	6
Only Managers	1

ScenDes was considered an easy-to-use tool and users have found it very relevant and useful for the organisations they belonged to. Nevertheless, *ScenDes* can be improved technically which, from our perception, would permit a more effective use. We herewith point out some positive and negative aspects considered as well as some suggestions from users.

Positive Aspects:

- *ScenDes* has an easy working environment and can be learnt easily and quickly.
- Users were generally satisfied about the possibilities of *ScenDes* and would consider using it in their daily work.
- The procedures were not too lengthy and users understood the steps. Error messages were not reported.
- Users identified *ScenDes* as a relevant tool for exploring planning options, not only for desertification, but also for land planning in general.

Negative Aspects:
- *ScenDes* implies GIS software and knowledge. Data treatment must be done *a priori*.
- *ScenDes* is not in compliance with the most used map formats in planning organizations – vector. It demands some extra work in converting and transforming data into raster data.
- *ScenDes* presents some absence of information [units on graphs and legends] and it is not careful on the management of cartographic data [no information on source and north arrow.

Besides the correction of mentioned problems, users suggested:
- A longer training time, since modelling tools have not yet been extensively used in planning organizations in Portugal.
- A clearer interface, meaning only parts that users can edit, should be visible.
- A more interactive tool, meaning more possibilities for users to add their numerical data, as well as regional related information.
- An easier to read output; not only a map, but also the highlight where major changes have occurred as well as variation indexes.

Some additional remarks:
- Users stated that *ScenDes* could not be used by regional or local organisations, because it was built for national scope analysis. Also, they have complained about the aggregation of some land use characteristics and of basic data. For some users, the land use map that was used did not include important national characteristics, such as the crop rotation system in agricultural areas. Although *ScenDes* is not suitable for very detailed analysis, for example city blocks, it can be set up for regional and city analysis. Pixel size, land uses categories and their level of aggregation can be chosen by users, thus overcoming the abovementioned remarks of the users.
- Users stated that introducing *ScenDes* in their organisations would not imply any organisational change. Our impression is that because users just briefly got to know about the possibilities of *ScenDes*, its use will be limited for now. We believe that as users start using *ScenDes* more effectively, they will understand the integrated approach that it demands as well as the work among different organisations that will be required. In our opinion both could very well lead to some organisational change.
- Users stated that they would not prefer a simpler tool. They prefer to have more control over data and changes, despite the complexity that it implies. This reflects users to be more interested on the process, than just the results. This is a positive aspect for an effective use of *ScenDes*, and SDSS tools comprising an integrated model in general.

5. CONCLUSIONS AND SUGGESTIONS

5.1 On *ScenDes* usefulness

Managers make a positive evaluation of *ScenDes* usefulness. It not only helps to study the desertification processes, but is also useful in land planning in general. Managers recognise that *ScenDes* enhances their organisation's work, and that it is particularly good to accompany the planning process, especially when setting goals and objectives, inventorying, evaluating alternatives of action and monitoring. Managers agree that *ScenDes* brings decision makers/technicians/civil society together, promoting communication and discussion.

5.2 On *ScenDes* usability

The majority of users have agreed *ScenDes* has an intuitive interface and is easy to use. In general, users were satisfied with the possibilities *ScenDes* offers. The tasks were not too long, easy to remember and no error messages were reported. Users understand the required investment in time, knowledge and data in order to fully work with the system and do not

consider it disproportional or excessive. Users claimed *ScenDes* was easy to learn, though training was needed.

5.3 On how *ScenDes* can be improved

Based on the results summarized in 5.1 and 5.2, we hereby conclude how *ScenDes* can be improved.

- Communication

Users do not fully understand the technical requirements for using *ScenDes*. Technical requirements such as GIS knowledge and the need for data treatment should be more clearly stated *a priori*. Users must know in advance if and how they can meet these requirements as we believe the opposite situation can jeopardize the use of the system.

- Training

Since modelling has not been extensively used as planning support, the provided training of half of a day was not sufficient for users to get realistic expectations on the possibilities and limitations of *ScenDes*. Training sessions should be longer and users' examples and interests/needs must be taken in consideration during training sessions.

- Technical Aspects

During the workshop, we have identified some missing information in the user interface that confused users. Some technical aspects can be improved such as introducing the missing information on charts, graphs, maps, as previously mentioned. By doing so it will be easier to understand what they can and cannot change. At the output level, in addition to the final map, variation analysis could be automatically calculated.

It is the authors' impression that users didn't get a full understanding of the possibilities and limitations of a SDSS such as *ScenDes*. Besides the comments already made regarding communication and training, this can be a symptom of the fact that most SDSS are born within research programmes with a strong scientific interest rather than in the spatial policy context with emerging needs. This aspect can nevertheless be minimized by increasing the communication between developers and users. An example of an iterative process with strong interactions between developers and users can be found in van Delden et al [2008].

Reflecting on the methodology used to assess usefulness and usability, we would like to make the following comments: On one hand, the interviews made it possible to understand the organisations' agenda and their managers. This was very positive because it enabled us to present *ScenDes* to them as an available tool for their problems and get them involved in this research. But because of their lack of time, only few managers tested the tool in the workshop. We believe that not having touched the tool could lead to a not very informed opinion about the relevance of the tool for their work.

As for the usability assessment, it was very positive to have adopted the workshop methodology. It permitted users to communicate more with the developer and discuss questions on difficulties in real-time. A less positive aspect was that we used theoretical examples, and not real cases. This was so because of the data requirements and shortage of time for this research. But we agree that the study of usability would be more reliable if users could work on a real planning question from their organisations. Therefore, to conclude this research, we will organize another workshop in which we will use real examples from the involved organisations.

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