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Jul 1st, 12:00 AM

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Van Delden, Hedwig; Ouessar, M.; Sghaier, M.; Belgacem, A. Ouled; Mulligan, M.; Luja, P.; De Jong, J.; Fetoui, M.; and Zaied, M. Ben, "User driven application and adaptation of an existing Policy Support System to a new region" (2008). *International Congress on Environmental Modelling and Software*. 108.
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iEMSs 2008: International Congress on Environmental Modelling and Software
Integrating Sciences and Information Technology for Environmental Assessment and Decision Making
4th Biennial Meeting of iEMSs, http://www.iemss.org/iemss2008/index.php?n=Main.Proceedings
M. Sànchez-Marrè, J. Béjar, J. Comas, A. Rizzoli and G. Guariso (Eds.)
International Environmental Modelling and Software Society (iEMSs), 2008

User driven application and adaptation of an existing Policy Support System to a new region

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Abstract: The development of a decision or policy support system is a very time consuming and expensive process. Reusing an existing system provides therefore major benefits. This paper describes the process followed when applying the existing MedAction Policy Support System, developed for Northern Mediterranean regions, to the Oum Zessar watershed in south east Tunisia. The paper presents the differences and similarities of the problems and processes in the different regions and describes how they relate to the adaptation of the existing model and the place the system could take in the decision-making process. Furthermore, it discusses the likelihood of its actual uptake in the Tunisian context based on six criteria discussed in a participatory approach with potential users of the system.

Keywords: Policy Support System (PSS); User requirements; Linking science to policy-making; Desertification; Integrated spatial planning.

1. INTRODUCTION

In the past decades a large number of systems to support decision making in regional planning have been developed. Some for a very specific task in a specific region, others as generic tools that can be applied to a wide range of topics at different locations. Since the development process of a decision or policy support system is normally a very expensive and time consuming process, reusing the system for a broad range of problems and reapplying it to different regions after its development would give great benefits. For most systems, however, it is not clear to what extent they can be reused and what the required effort is to apply them to new regions and embed them in new organisations.
This paper will discuss to what extent the current version of the MedAction Policy Support System (PSS), developed for the European context, can be applied to Northern African countries using the watershed of Oum Zessar in south east Tunisia as a first test case.

For the research presented, the following questions have been formulated:

1. To what extent are regional development problems in Northern Africa similar to those in Southern Europe?
2. To what extent are socio-economic and bio-physical processes in Northern Africa similar to those in Southern Europe?
3. To what extent is the institutional context in Northern Africa similar to the one in Southern Europe?
4. What needs to be adapted to the system to make it applicable for regions in Northern Africa?

5. Based on this case study, can (a system like) the MedAction PSS provide support to policy-making in Northern Africa?

To answer the fifth question, this research pays specific attention to the six elements that help to understand the failure or success of a PSS in practice (based on Van Delden et al, 2007):

A. Strategic value of the system: to what extent does the system provide an added value to the current planning practice? How does it provide support to mitigate main problems in the region?
B. Availability of appropriate data and models: what is available at present or can easily be collected?
C. Credibility of the system: do the users have faith in underlying assumptions?
D. Language of the system: does it connect to the world of the end-users?
E. Institutional embedment: where will the system be based in the organisation? Who is actually going to use the system? Where in the policy process is it most beneficial?
F. Culture: are people willing to adopt and use the system? Is there commitment to give the system a place in the planning process?

To provide the context of the research, we provide a brief overview of the MedAction PSS in section two and a description of the region and its characteristics in section three. The paper will provide answers to the research questions posed, following the methodology described in section four. In section five, we present the outcomes of the interaction with local stakeholders and scientists. Section six aims to provide some preliminary answers to the six questions that help to understand the potential for actual use of the MedAction PSS in Northern Africa and the Oum Zessar watershed in Tunisia in particular. The last section discusses the conclusions and provides answers to the five research questions formulated above.

2. THE MEDACTION POLICY SUPPORT SYSTEM

The MedAction PSS has been developed as a generic system for Northern Mediterranean regions to support integrated decision making in the area of sustainable farming, water resources, land degradation and desertification. It allows the user to explore the impact of a wide range of external factors and policy options on policy-relevant indicators by simulating future developments in the region over a time span of 20 to 30 years.

Its goal is to assist policy makers in (1) understanding the important processes in the region and their interaction, (2) indicate current or future problems in the region or river basin, (3) assess the impact of possible policy measures to mitigate the problems, (4) evaluate the different alternatives and (5) stimulate discussion and improve communication between the different actors involved in the decision-making process.

The system comprises of a wide range of spatial dynamic sub-modules, integrated into a single computerised system (see Figure 1 for main components and relations). The climate and weather module produces rainfall, temperature and radiation figures based on historic datasets and IPCC climate scenarios. These are used for calculating run-off and evapotranspiration in the hydrology module and the growth of plants in the plant growth module. The hydrology and plant growth module are strongly interconnected for the calculation of evapotranspiration, biomass and soil moisture. Incorporated on the bio-physical side are also modules to calculate the erosion, sedimentation and salinisation of soils. These modules determine the suitability of the soil for different types of crops and natural vegetation and also produce several desertification indicators.
Economic and demographic growth is translated into the land use functions: residential, agriculture, industry and tourism. These functions are in competition with each other in the land use module. This competition is simulated with a constrained cellular automata model that allocates the demographic and economic activities on the land use map. The land use class natural vegetation takes in space that is not occupied by other functions or that is restricted for the other functions by zoning plans. The land use classes agriculture and natural vegetation are further specified through respectively the modules farmer's decisions

and natural vegetation which produce the crop types and the natural vegetation types that will cover the locations for agriculture and natural vegetation. The growth of the plants (crops as well as natural vegetation types) is subsequently calculated in the plant growth module mentioned before. The last module in the PSS is the water resources module. This module calculates the amount of available water for irrigation and drinking water, and determines the water used by the different functions based on the maximum available amount and the price of water from different sources (groundwater, reservoirs, and desalinised water from the sea).

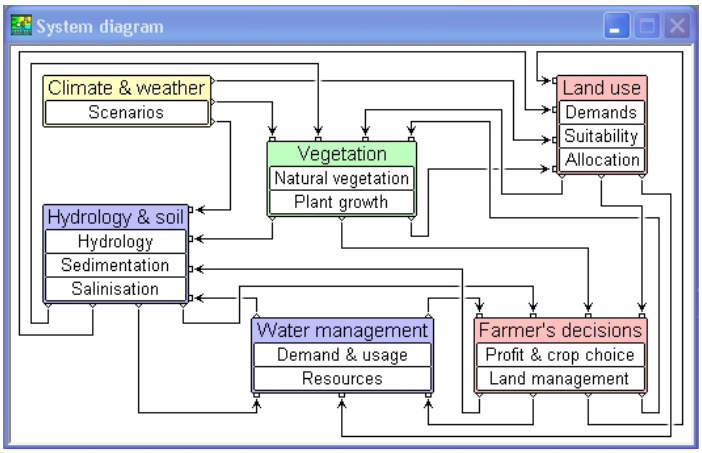

Figure 1. System diagram of the MedAction Policy Support System.

Each process is modelled at its appropriate geographical and temporal resolution. The finest spatial resolution is 100 by 100 meters; the land use module calculates on a yearly basis while the hydrology module has a variable time step in the order of minutes determined by the intensity and duration of the showers. To enable dynamic feedback loops between the different processes modelled, the MedAction PSS is developed with the **GEONAMICA®** software environment. This is an object-oriented application framework for building decision support systems based on spatial modelling and (geo)simulation (Hurkens et al, 2008). More information about the MedAction PSS can be found in Van Delden et al (2007).

3. THE OUM ZESSAR WATERSHED

The Oum Zessar watershed is chosen because this region can be considered representative of the arid southeastern Tunisia from an ecological, hydrological as well as a socio-economical point of view (Chahbani, 1984; De Graaff and Ouessar, 2002). The watershed covers a territory of 10 imadas (lowest administrative unit in Tunisia) belonging to three counties (Béni Khédachi, Médenine North and Sidi Makhlouf). The total population of the watershed is estimated, according to the population census of 1994, to 24188 inhabitants. The household number is 5758 with an average family size of 5.5. The area encompasses the mountains of Matmata (Béni Khédache) in the south-west, the Jeffara plain (around Koutine) and the saline depression (Sebkha) of Oum Zessar and ends in the Mediterranean sea (Gulf of Gabès).

Rangelands are the dominant land use in the study area. The vegetation is mostly steppe but the species composition is highly variable depending on relief and soil type. Crop cultivation takes up an important part of the land area. The climate of the pre Saharan Tunisia is characterized by hot and dry summers that last from May to August. Rainfall is very irregular with measured annual totals varying between 14 mm (min) and 590 mm (max) to average around 170 mm (Koutine station). This results in highly variable yearly yields and accompanying risks for the local population. To deal with these risks many households depend on several sources of income. Nonetheless, poverty remains a crucial problem.

4. METHODOLOGY

The process followed while applying the system to the new context and user community very much resembles that of the development process of integrated spatial decision support systems (ISDSS) – and Policy Support Systems – as described by Hurkens et al. (2008). This development process can best be described as an iterative process of communication and social learning amongst three involved parties – as shown in figure 2. First, there are *policy makers and analysts*, the users of the system. They provide the policy context and define the problems, functions and usage of an ISDSS. Second, there are *scientists* responsible for the main model processes and choices of scale, resolution and level of detail. Third, there are *IT-specialists* who design the system architecture and carry out the software implementation of the models and user interface. 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 and helps each group to gain a better understanding of the needs the others have and the possibilities they offer. For this understanding to take full effect, an iterative approach is best suited.

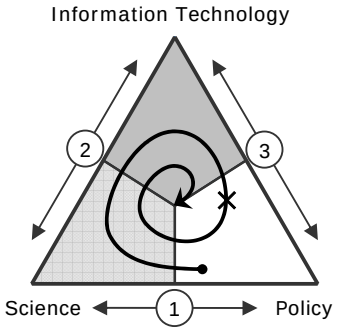

Figure 2. ISDSS development process

Where the original development process starts at the black dot in the figure, the application process described in this paper starts after a first iteration loop at the black cross. At this point a prototype is already available and discussions during a first interaction focus around the question if an ISDSS or PSS would provide a contribution to the decision making process and if so, if the system presented would be a good starting point.

To stimulate interaction and discussion between the different groups, we selected workshops as the appropriate format to answer the research questions. During the workshop sessions we discussed open questions and tried to reach consensus about the problems and processes in the region as well as the important elements for adaptation and application of the system. In these discussions local stakeholders contributed to the policy section of figure 2, local scientists to both the science and the policy section and the team that originally developed the MedAction PSS and applied it to Southern European regions, contributed to the science and IT sections.
Throughout the process both the local stakeholders and scientists were seen as (potential) users.

In the application process we take the following steps:

1. First meeting between developers and local scientists with the aim to:
   1.1. Understand the main problems of the region
   1.2. Present and discuss the existing Policy Support System
2. Application of the existing Policy Support System to the new region
3. Second meeting between developers and local scientists with the aim to:
   3.1. Understand the decision-making process in the region
   3.2. Become aware of data limitations
   3.3. Understand important processes in the region
   3.4. Discuss the extent to which the existing model is able to represent the important processes and if not, the effort to incorporate them
4. First user workshop with involvement of stakeholders, scientists and developers with the aim to:
   4.1. Review the findings of the previous meetings from the point of view of the stakeholders
   4.2. Discuss the main functions (e.g. analysis, communication) of the system

   4.3. Discuss the main external factors, policy options and indicators that should be incorporated in the system
   4.4. Discuss the institutional context in which the system could be used
5. Prioritisation of possible adaptations to the existing system
6. Adaptation of the system
7. Second user workshop with involvement of stakeholders, scientists and developers with the aim to:
   7.1. Review the adaptations
   7.2. Discuss the potential for its actual use
   7.3. Develop an implementation plan
8. Implementation of the system in the user organisation(s)

As described above, the development –and application– process is an iterative process. The eight steps described in the methodology should therefore not be followed in a very strict sense and time should be reserved for feedback loops between the different steps.

5. RESULTS FROM STAKEHOLDER AND SCIENTIST INTERACTIONS

For the application process we have selected as a first group of potential users the stakeholders who are currently involved in regional development at a strategic level in the Oum Zessar watershed:

- Commissariat Regional au Développement Agricole (CRDA) de Médenine, the representation of the Ministry of Agriculture and water Resources at the regional level (province of Médenine), in charge of the implementation of the agricultural development programs.
- Union Régionale de l'Agriculture et de la Pêche (UTAP) de Médenine, the regional representation of the national farmers union.
- Association des Jeunes de Zammour (AJZ), a local NGO based in the mountain locality of Zammour.

Furthermore, during the entire process, we collaborated with a local organization that takes the role of local scientist as well as potential user:

- Institut des Régions Arides (IRA), a leading research organisation in the field of arid areas and desertification, actively involved in communicating scientific knowledge to policy-makers and other stakeholders.

Besides the potential users defined above, scientists and IT-specialists from King's College London and RIKS were also involved in the application process.

At present, we have carried out the first four steps of the methodology described in the previous section. A summary of the information and recommendations obtained through the interactions with local stakeholders and scientists is provided below.

Through the workshops, the main issues in the region, the important drivers for change and the relevant indicators became apparent. The issues and related indicators are presented in table 1. The drivers cannot be directly linked to one issue or indicator in particular since they impact on the integrated system in its totality. The following main drivers are selected:

- Globalization on the prices of crops;
- Climate change and variability (droughts);
- Changes in EU migration policies;
- Introduction of new crop types ;
- Subsidies;
- Water resource allocation between sectors;
- Soil and water conservation strategy.

On the bio-physical side not many of the processes have to be adapted. The main difference is the cause of erosion. Where rainfall is driving most of the erosion in the current application, wind is a much more important cause in Northern Africa. Furthermore natural vegetation type groups have been adapted to local species and transition rules for succession and degradation have been adjusted.

Table 1. Main issues and indicators in the Oum Zessar watershed.

Main issue	**Indicator**
Sustainable economy	- long term profits in main economic sectors - household income
Water resources	- water shortage in the main sectors
Land degradation and desertification	- environmentally sensitive areas (ESA)

Larger adaptations are required to incorporate the socio-economic processes. Where in many European countries farmers often depend on their income from farming, in Northern Africa the household income in general depends on a combination of the following sources: crops, livestock, tourism or money sent over due to internal (large cities) or external (Europe) migration. Furthermore, household income and survival are much larger issues in Northern Africa than in Southern Europe.

There are also several drivers that are similar in nature, but have a different extent. Climate variation, for example, is much larger in Northern Africa than in Europe. In the model however, incorporating this variability doesn't need any special adjustment and changes can simply be incorporated by entering the correct data sets and parameter values.

At last, there are some proposed adaptations that would also improve the original model when applied to the European areas. Examples of these adaptations are: the possibility to have various crop cycles over the year, the possibility to have mixed land uses (tree and annual crops combined on one field) and the possibility to incorporate grazing densities (the current model deals with grazing as a yes/no component).

Besides the contents of the system, we also discussed its application domain and the way the system could be used in practice in Tunisia. A crucial element mentioned in this regard was the bottom up development of policies. Since local initiatives can be brought forward in the decision-making process at regional level, stakeholders have a high interest in using the system by themselves to investigate the impacts of the actions they propose and to discuss those proposed actions with other stakeholders.

6. POSSIBILITY FOR PRACTICAL USE

This paragraph discusses the findings of the six questions that help to understand the (potential) failure or success of a PSS in practice as posed in the introduction.

According to potential users, the MedAction system can provide an added value to current planning processes by providing some insight in the future development of the region and the interrelation of the different processes at stake. Also its explicitly spatial nature was mentioned as one of its main advantages. From discussions with stakeholders it became apparent that it could provide support to the main issues they are dealing with –regional economic development, water resources and desertification– although some of the details of the processes would need to be adapted to better fit the Northern African context in general and more in particular that of the Oum Zessar watershed in Tunisia.

Availability of data and models does not seem to be a limiting factor to use the system. Since the Institut des Régions Arides has collected a large amount of bio-physical as well as socio-economic data and has a very good understanding of the processes at stake in the region, it should be feasible to produce a first prototype. Based on this, focused data collection can be established to fill in the missing elements and improve the prototype.

At present, the credibility of the system has not been discussed to a vast extent. Since the application to the Oum Zessar watershed has only been set-up recently, calibration and validation are not yet finished. Assumptions made in the model for the Northern Mediterranean have been discussed and questioned and adaptations have been proposed to some parts of the system.

The language question can be taken literally and in a more abstract manner. Through discussions with stakeholders it became clear that it would be a great benefit to them if the language of the system would be French (or Arabic), rather than English. The current system already provides a number of possibilities to enter relevant scenarios and to provide the output in meaningful indicators: environmental sensitive areas, water shortage and long-term profits in the agricultural sector.

When discussing the use of a policy support system, often the distinction is made between the user, the person or organisation actually operating the system, and the end-user, the person or organisation using the results of the model. During preliminary discussions with the scientists in the region it was suggested that the model would be operated by the Institut des Régions Arides, a governmental research organisation that gives advice to local and regional government and other stakeholder groups operating in the region; the organisations that were seen as the potential end-users. After discussions with the stakeholders however, it became evident that they would like to operate the system by themselves as well. Since this requires an in-depth knowledge of the different processes that are incorporated in the system, it will be investigated during the next phase of the process if the human capacity is available at their organisations and if training them in the actual use would be the best way forward.

Both stakeholders and scientist have shown a large interest in using the system. The organizational culture in the different organizations seems very open to explore new initiatives and tools.

7. CONCLUSIONS AND RECOMMENDATIONS

The approach followed in applying the existing MedAction PSS to a new region provides promising results. It focuses on both the context of the system as well as the place it takes in the decision-making process. A first evaluation of the uptake of the MedAction system by regional policy makers and other stakeholders resulted in a positive response. However, given the early stages of the application process it is too preliminary to talk about a successful use of the system in Northern Africa.

Based on the discussions with local stakeholders and scientists as well as developers of the original model, we come to the following conclusions regarding the five research questions posed in section one:

1. In Northern Africa poverty reduction has a higher emphasis than in Southern Europe. Furthermore, climate variability is much higher and with a large part of the region depending on rainfall rather than irrigation, agricultural and natural vegetation are highly impacted by the yearly changes, enlarging the economic risk.
2. There are large similarities between processes related to desertification and regional development in Northern Africa and Southern Europe. In both regions a combination of bio-physical (climate, hydrology, erosion, salinisation, vegetation) and socio-economic (demographic, economic, land use and land management) processes play a crucial role in the dynamics of the region and as a result its future development. The details of the processes as well as the main drivers are however to some extent different, especially when looking at the socio-economics.
3. Compared to the institutional context in Southern Europe, bottom-up processes seem to play a larger role in Northern Africa. This might result in a different way the system will be used in the latter.
4. Main adaptations to the system to make it better applicable for regions in Northern Africa have to do with the way farmer's (or households) make there decisions. The current farmer's decision module assumes that the entire income of the farmer is dependent on agriculture. For the Northern African context it would be more appropriate if the household income depends on a number of factors like crop production, live stock, tourism and income from emigrants.
5. First interactions with local stakeholders and scientists show a large motivation to actually use the system. Added value of the system is seen in the recognition of problems and the integrated impact assessment of –a combination of– policy options on the economic, ecologic and social development of the region. Moreover (potential)

users feel that it can be used in an interactive planning process where actors from different disciplines come together to discuss the impact of different alternatives for improving sustainable regional development. However, the implementation process has just started and only a close interaction with the stakeholders during the coming period can ensure an actual uptake of the system.

The proposed methodology includes the presentation of an existing system to potential users. This approach has a number of advantages, since it shows what is possible and therefore offers a good starting point for focused discussions, but it also has the drawback that the stakeholder group already is confronted with possible solutions before going through a problem definition process. Since model and software development is a very time consuming and therefore expensive process, in our opinion, the main benefits of this approach –reusability of existing material– outweigh its potential limitations.

The methodology followed in the current research included open questions that were answered during workshop sessions. Since there was mutual respect between the different participants and a high degree of openness, this format worked very well. Most likely in the next phase, where certain elements have to be discussed in more detail with the different (science and policy) experts, a format that combines individual meetings and workshop sessions will be more appropriate.

A local (research) partner has been found essential in the application of the MedAction PSS to a new region. Not only has such an organisation insight in the relevant socio-economic and bio-physical processes in the region (or knows who has this insight), it is also able to raise interest with the local stakeholders and select the relevant stakeholders for the application process.

ACKNOWLEDGEMENTS

The authors wish to thank the European Commission for the financial support of the project DeSurvey: A Surveillance System for Assessing and Monitoring of Desertification (IP-003950).

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