Linking Narrative Storylines and Quantitative Models To Combat Desertification in the Guadalentín, Spain

Kasper Kok

Hedwig Van Delden

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Kasper Kok[1], Hedwig van Delden[2]

[1]Laboratory of Soil Science and Geology, Wageningen University, Wageningen, the Netherlands.
E-mail: kasper.kok@wur.nl
[2]Research Institute for Knowledge Systems, Maastricht, the Netherlands

Abstract: Desertification in Spain is a largely society-driven process, which can be effectively managed only through an understanding of ecological, socio-cultural and economic driving forces. This calls for a more active role of decision makers and other stakeholders. We present a promising approach, involving stakeholders in the scenario development process and linking these narrative storylines with an integrated quantitative model. Within the framework of a larger EC-financed project, dealing with desertification in the Mediterranean region, multi-scale scenarios were developed for Europe, the Northern Mediterranean and four local areas. In the same project a Policy Support System (PSS) was developed. The main objective of the present exercise was to establish a link between the qualitative scenarios and the PSS for the watershed of the Guadalentín River in Spain. From the results of two scenario workshops, three scenarios were selected, all linked to the same Mediterranean scenario. Our selection aimed at maximising both the variety in the narrative storylines and the expected output of the PSS. The scenarios were subsequently formalised, ensuring that the same information was present for all three scenarios; semi-quantified ("translated") by linking them to the main entry points of the PSS; and quantified by parameterisation of the model. Although model runs have not yet been carried out, preliminary results indicate the potential for the constructed quantitative scenarios. The paper illustrates the practical potential and pitfalls of linking qualitative storylines and quantitative models. Future research should, however, also focus on the more fundamental theoretical obstacles that are easily overlooked.

Keywords: scenarios; spatial modelling; Policy Support System; participatory; linking qualitative and quantitative methods

1. INTRODUCTION

Desertification in Spain is largely a society-driven problem, which can be effectively managed only through a thorough understanding of the principal ecological, socio-cultural, and economic driving forces [UNCCD, 1994]. This Integrated Assessment approach also calls for a much more active role of decision makers and other local stakeholders during all phases of the process [Rotmans, 1998]. A particularly pressing issue is establishing the link between qualitative outputs from employing participatory methods and quantitative, data demanding, spatially explicit models. To tackle the problem, various different methods are being developed, including e.g. Agent Based Models [Parker et al., 2002], that can be directly parameterised by stakeholders [e.g. Barreteau et al., 2001]. Here we present another approach by linking qualitative narrative storylines, developed during scenario workshops, and a Policy Support System (PSS). The work is part of a larger European project, MedAction.

1.1 MedAction

MedAction (see Appendix) is an EC-financed project within which an information and decision-support base on land degradation is being developed

Table 1. Main results and methods employed during stakeholder scenario workshops within Module 1 of MedAction.

	Present (2003)	*Short term (2008)*	*Long term (2008-2030)*	*Long term (2030)*
Workshop # (date)	1 (Oct/Nov 2002)	2 (Jun/Jul 2003)	2 (Jun/Jul 2003)	1 (Oct/Nov 2002)
Grouping	Individual and All	Groups and All	Groups	Groups
Main method	Post-its and discussion	Discussion	Backcasting	Collage and forecasting
Results	Main factors	Major current trends	Desirable futures	'Real' futures

to assist decision-makers from the local to the European level in the formal and informal decision and policy making process to combat desertification in the Northern Mediterranean Region. The specific problems of desertification and mitigation measures are addressed at the European, Mediterranean and local scale, with the ultimate goal being to aid local decision-making with regard to policy formulation for sustainable land management at the local level. Work was carried out in four local case studies: the Guadalentín (Spain); Val d'Agri (Italy); Alentejo (Portugal); and the island of Lesbos (Greece). A simplified flow-chart of the main activities within MedAction is given in Figure 1, highlighting components important in this paper.

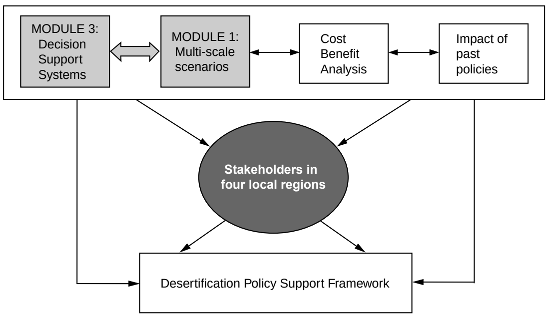

Figure 1. Simplified flow-chart of main activities within MedAction. Grey shades indicate components important in the paper.

Module 1 of MedAction was coordinated at the International Centre for Integrative Studies (ICIS) in Maastricht, the Netherlands, and dealt with scenario development at European [Kok et al., 2003]; Mediterranean [Kok and Rothman, 2003], and local [Kok and Patel, 2003] levels. Local scenarios for the various local case studies were developed during series of workshops with 20-25 local and regional stakeholders. Various scenario-development methods were tested. Four main products can be distinguished: a *story of the present* characterising the perception of the local stakeholders on the situation in their region; a *story of the future* in 2030 that was obtained during a forecasting [see also Kasemir et al., 2000] session; an *extension of the present* representing the situation in 2008 based on an extrapolation of current trends; and a *backcasting* exercise [Dreborg, 1996; Robinson, 2003], reasoning back from a desirable end-point in 2030 to short-term measurements that are necessary to realise this future. The diversity of methods has resulted in a good overview of the perception of stakeholders on the present situation; short-term fears; and long-term hopes and expectations. The methods and results are summarised in Table 1; a full description can be can be downloaded on http://www.icis.unimaas.nl/medaction/download.html.

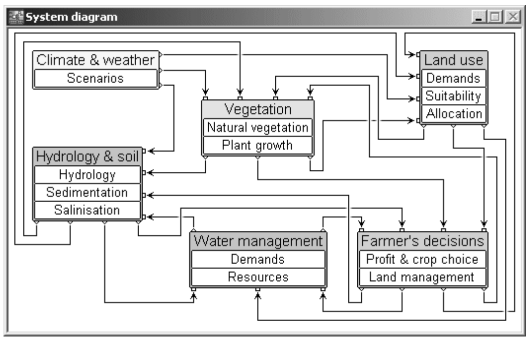

Figure 2. Simplified structure of the Policy Support System as developed in Module 3 of MedAction.

Module 3 dealt among other things with the development of a Policy Support System (see Figure 2): a software instrument to support policy-making at the regional level, developed by the Research Institute for Knowledge Systems. The MedAction PSS has been developed with the objective to address a number of policy themes concerning water resources, sustainable agriculture, desertification and land degradation in Mediterranean regions. Problems, goals, policy options and policy indicators have been collected and structured for each of these themes, and translated into a conceptual framework. From this conceptual framework a policy support system is being designed and developed incorporating socio-economic as well as physical models. The PSS supports policy-makers in understanding the impacts of autonomous developments within a region as well as the impacts of external influences on the region, such as economic and demographic growth and climate change. All impacts can be measured by means of a number of policy relevant indicators (e.g. profits in the agricultural sector, forested area, suitability of the soil for agriculture or natural vegetation, water use and availability, land use), which change dynamically during the run of a simulation. The PSS is developed as a generic system and is applied in particular to the Guadalentín river basin in Spain. Previous versions of this system have also been applied to the Marina Baixa region in Spain and the Argolidas region in Greece. The MedAction PSS will be described in more detail in the presentation of Van Delden et al. (2004) at this conference. More information on the predecessor of the MedAction PSS, MODULUS, can be found in Engelen [2003] and Oxley et al. [in press].

1.2 Objectives

The main objective of this paper is to establish the link between the qualitative scenarios developed in Module 1 and the PSS developed in Module 3 of MedAction. This paper focuses on the practical application in the watershed of the Guadalentín in southeastern Spain.

2. METHODS

2.1 Selecting the Scenarios

The series of workshops in the Guadalentín yielded a wealth of scenarios. We focused our selection on the forecasting and backcasting exercises, resulting in seven local scenarios, linked to three Mediterranean scenarios. From these we selected, for the exercise described, those two scenarios that were linked with the European scenario Convulsive Change, in which climate change is as disruptive as some are now predicting, triggering a series of severe droughts and desert formation. The forecasting scenario (*Scenario I: Likely future*) provides a most likely future under these Mediterranean developments; the backcasting scenario (*Scenario II: Desired future*) is based on the desirably future of a strong agricultural sector. A third scenario (*Scenario III: Water shortage*) was added, where one of the key assumptions in the first two scenarios – the construction of a canal from the Ebro River– was omitted, thus strongly limiting water availability and the effects thereof. This third scenario was thus not directly formulated by the stakeholders, although the possibility was discussed during the workshops.

The scenarios were chosen to maximise both the variety present in the narrative stories, as well as the variety of the expected spatially explicit results. The link between the narrative storylines and the PSS was not complete. Social changes in the narratives, for example, could not always be quantified, while strongly non-linear changes in the stories could not always be incorporated in the PSS. Similarly, detailed information on e.g. soil conservation measurements and land management practices in the PSS could not be extracted from the narrative storylines and were set at default values.

2.2 Formalising the Scenarios

These three narrative scenarios were formalised using the Factor – Actor – Sector framework that was also used in the development of the European and Mediterranean scenarios (see Table 1). This helped in maintaining the links with higher level scenarios. The developments remain qualitative.

2.3 Translating the Scenarios

These formalised stories were then quantified to the extent possible by linking them to the main entry points of the PSS. First a selection was made of parameters in the PSS that have a link with the scenarios as formalised. For each of these parameters, it was then indicated what the expected change was in each of the three scenarios. Change was semi-quantitative, ranging from +++ (very strong increase) to --- (very strong decrease). This methodology was also applied in earlier work by White et al. [2004]. Below are the most important parameters in the PSS that were considered during this translation. Grouping is by main components in the PSS as depicted in Figure 2.

Table 2. Summary of the formalised scenarios used as input in the PSS, by the main Factors, Actors and Sectors.

FAS	*Scenario I*	*Scenario II*	*Scenario III*
Factors			
Water availability	Increasingly limited due to drought	Limited, distribution favours agriculture	Strongly limited, no "Ebro water"
Migration	Rural-urban migration European Sunbelt	Fewer permanent tourists	Strong rural-urban migration, less immigrants Morocco
Sectors			
Agriculture	Increasingly difficult position	Multi-functional, favoured for water	Lack of water, although still favoured
Tourism	Booming	Eco-tourism, less in numbers	Lack of water stops expansion
Actors			
Businesses	Large-scale, mass tourism, smallholders disappear. Industry important	Small-scale favoured, industry under pressure	Lack of water limits developments

LAND USE MODULE: Total land demand for Agriculture; Rural residential; Dense residential; Industry & commercial areas; Tourism; Expats, Forest reserves.

CLIMATE MODULE: Scenario for future climate change, based on IPCC scenarios. Main factors are precipitation, temperature and radiation.

WATER MANAGEMENT MODULE: Defined by resource (aquifer, reservoirs (including Tajo and Ebro water), desalinised sea water) and by function for the demands. Three main parameters were included: price (also per source); quantity (per source, per sector or per person/hectare); distribution (per sector).

An important input in this module is the presence/absence of irrigated agriculture, represented by a binary map showing where irrigation from each water source is possible; with a choice between drip or spray irrigation.

FARMER’S DECISION MODULE: The choice for different crop types (including no crop or abandoned land) depends on, among other things, the market price of crops, subsidies, taxes, farmers' resistance to change, water availability and the calculated yield or suitability. Parameters adapted based on the scenarios were market prices, subsidies, farmer’s resistance to change, and the introduction of "new" crops which are better resistant to dry soils.

OTHER: Policy relevant parameters include: zoning maps for each function, construction of new roads, canals and check dams, dredging of the reservoirs, terracing, ploughing.

2.4 Quantifying the Scenarios

The last step was the actual parameterisation of the PSS. We used a baseline scenario for all parameters that had no relation with the narrative storylines. For example, there are detailed modules for hydrology, soil erosion, salinisation and plant growth, for which not much information could be extracted from the qualitative scenarios. The output of these modules is, however, influenced by the impacts of the different scenarios. The possible futures in turn are also influenced by the output of the modules, since the core of the PSS is an integrated dynamic model with strong feedback loops between the processes represented. In the parameterisation process, we were as consistent as possible. In general, "+++" translated into 3% more and "---" into 3% less. However, many small additional assumptions were necessary, given the amount of parameters in the PSS that were not explicitly referred to in the narrative stories.

2.5 Running the Model

Unfortunately, the final results of the model runs were not available in time to be included in the proceedings of the conference. Preliminary results indicate that the three scenarios translate into significantly different land use patterns. However, a full analysis of how the variability of the input scenario translated into a variability of the output maps has not been conducted yet.

In order to get an idea of how the results will look like, a few of the input and dynamic output maps of

Figure 3. Examples of maps of the Guadalentín watershed, used as input in the Policy Support System.

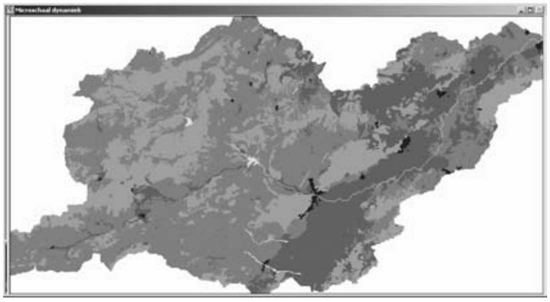

Figure 3a. Land use patterns. Black: built-up areas; dark grey: irrigated agriculture; medium grey: dryland agriculture; light grey: natural vegetation; white: water bodies.

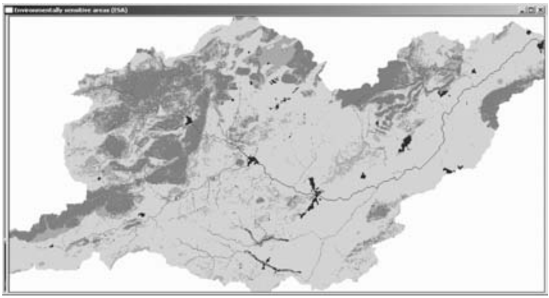

Figure 3b. Environmentally Sensitive Areas (ESAs). Black: = built-up areas and water bodies; dark grey: critical; medium grey: fragile: light grey: potential.

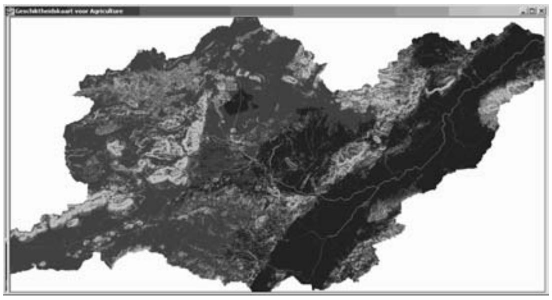

Figure 3c. Suitability for agriculture. Light grey indicates a low suitability; dark grey tones a high suitability.

the PSS are given in Figure 3. Presented are the input land use patterns; the suitability for agriculture; and the environmentally sensitive areas (ESAs), which are measure for the potential for land degradation. The suitability map is calculated yearly and can be used as an indicator for land degradation, but a key input in the crop choice model. The ESA map is also calculated on a yearly basis, but is not used as an input in other modules.

3. DISCUSSION

In this article we have illustrated how narrative storylines can potentially be linked to a quantitative model. With the presented detailed methodology we hope to have emphasised some of the potential *practical* pitfalls during translation. We want to particularly stress the potential difficulties when linking a highly complex model with many parameters and sub-modules to scenarios that are partly developed by laymen and that therefore sometimes lack 'scientific' argumentation and are not always internally consistent.

We have, however, not touched upon the *theoretical* considerations. By successfully solving practical problems, important theoretical questions might not receive the attention that is needed. We hope to further elaborate on:
What is the feasibility of linking qualitative scenarios that include surprises, radical system changes, and non-linearities to a model that may have limited possibilities to deal with these changes?
How to deal with inconsistencies typically present in narrative storylines that are developed partly by non-experts?
To what degree do the worldview of the scientists as represented in the PSS and the worldview of the local and regional stakeholders as formalised in the scenarios match?

What we want to achieve in the long run is a bottom-up, top-down cycle, in which those and other questions are addressed and dealt with by scientists, policy makers, and the general public alike.

4. CONCLUSIONS AND RECOMMENDATIONS

- This paper has demonstrated that it is *practically* possible to link qualitative storylines and quantitative models, despite a number of potential pitfalls.
- A successful practical link is, however, no guarantee for a successful link from a *theoretical* point of view. Inconsistencies in the participatory stories and radical system changes are but two examples of potential theoretical obstacles.

We therefore need to focus future efforts of linking qualitative and quantitative scenarios on:

- Synchronising the underlying assumptions of mathematical models and the mental models from which the local stakeholders reason.
- Involving stakeholders in some phases of the construction of mathematical models.

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6. APPENDIX

MedAction: Policies to combat desertification in the Northern Mediterranean region. Research project supported by the European Commission under the Fifth Framework Programme and contributing to the implementation of the Key Action 2: "Global Change, Climate and Biodiversity"; Subaction 2.3.3 "Fighting Land Degradation and Desertification". Research period: 2001-2004. Website: www.icis.unimaas.nl/medaction.