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APPLICATION OF THE NETSYMOD APPROACH IN SUPPORT OF DECISIONS ABOUT IRRIGATION MANAGEMENT

A. Fassio[*], C. Giupponi[*,], A. Sgobbi[*] and J. Mysiak[*]**
[*] Fondazione Eni Erico Mattei, Corso Magenta 63, 20123 Milano, Italy
[**] Dipartimento di Produzione Vegetale - Università Statale di Milano,
Via Celoria 2, 20133 Milano, Italy

SUMMARY - There is an urgent need to develop new methodologies for linking analytical methods and participatory-based approaches in integrated water resources management. The NetSyMoD (Network Analysis – Creative System Modelling – Decision Support) approach is the result of research carried out at FEEM in recent years. It is a methodological framework and a suite of tools aimed at facilitating the involvement of stakeholders in decision/policy making processes related to environmental matters.
This paper refers the application of NetSyMoD to the Italian case study within the EU-funded ISIIMM project, where the implementation of a new integrated approach to water management is foreseen: a dual water system providing non potable water for landscape purposes and pressurised water for irrigation. The aim of the study was to: (i) identify and involve local actors in the planning process of a project for restructuring of the irrigation system; (ii) collect information and opinions concerning the change of irrigation system; (iii) contribute to the evaluation of the rationality of the project in the light of alternative possible future evolutions of the territory.
The paper describes the general framework, its specific features and the above-mentioned concrete application in support of decisions about agricultural water management.

Key words: Public participation, water management, DSS, creative system modelling

RESUME *– Dans le domaine de la gestion intégrée des ressources en eau, il y a un besoin pressant de développer des nouvelles méthodologies pour lier méthodes analytiques et approches participées. L'approche de NetSyMoD (Analyse de Réseau - Modélisation Créative de Systèmes - Aide à la Décision) est le résultat de la recherche effectuée par FEEM. Il s'agit d'un ensemble d'outils qui visent à faciliter la participation des porteurs d'intérêt dans les processus de prise de décision politique et de décisions liées aux problèmes de l'environnement. L'approche a été appliquée à l'étude de cas italien du projet ISIIMM, puisque une nouvelle approche intégrée à la gestion de l'eau est prévue: un système duel de l'eau qui fournit eau non potable pour le paysage et eau pressurisée pour l'irrigation. Le but a été: (i) d'identifier et d'engager activement les acteurs locaux dans la planification d'un projet sur restructuration du système d'irrigation; (ii) rassembler information et avis au sujet du changement de système d'irrigation ; (iii) contribuer à l'évaluation de la rationalité du projet à la lumière de possibles évolutions du territoire. L'article décri le cadre général de la méthodologie, ses fonctionnalités spécifiques et l'application concrète mentionnée ci-dessus pour l'appui de décisions sur la gestion de l'eau pour l'agriculture.*

Mots-clés*: Participation publique, gestion des ressources en eau, SAD, modélisation créative de systèmes*

INTRODUCTION

Water has always had an essential place in the Mediterranean culture. It usually represents a key limiting resource: efficient use and allocation are paramount to sustainable development, increased quality of life and ultimately peace.

Moreover, as encouraged by recent EU policies[1], multi-stakeholder participation should be considered as a crucial asset of any (irrigation) water management scheme and 'consensus building' an essential ingredient to guarantee the expected outcomes and, consequently, progress. Communication between different institutional levels and stakeholders needs to be improved and conflicts might thus be alleviated by letting local communities participate at different stages of the decision-making process, and giving them a share of active responsibility[2]. On the other side, a more effective consensus building process could be of major benefit to governmental authorities, starting from a common understanding of the problems at hand, as a first step towards priority identification. Public participation could therefore be intended as a process to improve decision-making, by ensuring that decisions are soundly based on shared knowledge, experiences and scientific evidence, that decisions are influenced by the views and experience of those affected by them, and that the new arrangements are accepted by the interested parties.

It is of utmost importance to bear in mind that public participation is a complex process for which no blueprint exists and, therefore, must be shaped according to the needs, the available means and tools. In the field of natural resources management, there is a need to develop and apply robust methodologies to link formal, analytical tools provided by the scientific community and qualitative information and cognitive models that result from participatory approaches.

A new approach called NetSyMoD was conceived as the result of several years of research in the field of environmental evaluations and decision making carried out at Fondazione Eni Enrico Mattei (FEEM) within the Natural Resources Management Research Programme. NetSyMoD stands for Network Analysis – Creative System Modelling – Decision Support. It is a flexible but comprehensive methodological framework envisaging a suite of tools aimed at facilitating the involvement of stakeholders or experts in decision making processes requiring the participation of multiple actors (Mysiak and Giupponi, 2006). The framework has been devised to tackle problems commonly encountered under integrated water management, as it originates from a series of European research projects in support of the EU Water Framework Directive.

NetSyMoD was applied in the MEDA Water project ISIIMM[3], to manage and facilitate the participatory process of the actors involved in the Italian case study and to test the various components of the approach itself.

The main concern of the ISIIMM project is irrigation management and its aim is to share experiences, knowledge and build new perspectives for sustainable water management in Mediterranean agricultural systems involving local partners, water users, citizens, development agents, researchers and administrations. FEEM is the National Coordinator and Scientific Partner in charge of the implementation of the case study located the province of Treviso, in the north-eastern part of the Italian peninsula. The Piave River is the most important water course of the province and the main water supplier of the whole territory. However, although the Piave basin has always offered an ample availability of water resources to satisfy different demands, in the last 50 years the increase of water demand was not always met by a sufficient supply. This brings about a conflict, called "The Battle of the Piave", between new requirements to give back water to the river, safeguard the natural environment and the competition between hydroelectric power production and irrigation.

[1] Article 14 of the Water Framework Directive (2000/60/EC) itself specifies that Member States shall encourage the active involvement of all interested parties in the implementation of the Directive and development of river basin management plans. Furthermore, the central concept of 'integration' includes the 'integration of stakeholders and the civil society in decision-making', by promoting transparency and information to the public, and by offering a unique opportunity for involving stakeholders in the development of river basin management plans (See also EC, 2003).

[2] In the EU document "Water for Life – EU Water Initiative, International Cooperation – from knowledge to action" this paradigm is elegantly condensed in the following statement: "the more the approach to water use and management is perceived as being 'owned' by communities – rather than being imposed from outside or being perceived as such – the more effective the policy and its implementation will be".

[3] "Institutional and Social Innovations in Irrigation Mediterranean Management" – Project funded by the European Community under the MEDA Water Programme initiative (Contract No. ME8/AIDCO/2001/0515/59763-PO16). http://www.isiimm.agropolis.org.

In such a context and in order to contribute to a more balanced framework of exploitation of the Piave's resources, the "Destra Piave" Land Reclamation and Irrigation Association[4] intends to restructure the irrigation system in an area that is developing fast from rural to peri-urban by substituting low-efficiency gravitational irrigation with more efficient systems such as a pressurised system with sprinkler irrigators. This project is part of a wider, long term, integrated water management project that consists in the construction of a dual water distribution system that provides pressurised water for irrigation and non potable water in urban areas. The non potable water line would be used for landscape purposes (irrigation of gardens, car washing and other uses connected with production processes). The project therefore aims at providing a more efficient irrigation system and at a more efficient use of drinking water.

One of the crucial aspects that emerged in the development of the Italian case study is related to the involvement of the relevant local stakeholders, concerned with the use and management of water resources in the area. To this purpose and to bring them together to stimulate dialogue on the road towards best water management and allocation of water for irrigation, the NetSyMoD approach was applied.

After a first phase of interviews, meetings and an analysis of social networks, key actors have been invited to participate to a Creative System Modelling Workshop (held in Treviso 14 December 2005). The purpose of the seminar was to put them together to exchange views and experiences, to discuss future scenarios and specifically to evaluate the rationality of the new irrigation system project.

In the next paragraphs, a description of the methodology will be given and a description of its application in the Italian case study will be presented.

THE NETSYMOD APPROACH

As previously NetSyMoD is aimed at supporting and managing policy- decision-making processes for natural resources management[5], including any process in which a choice has to be made by examining the information available on the given issue. The problem itself, the information, and the choice set are defined with the contribution of different actors, who may be experts, or the stakeholders and the decision makers that are either formally or informally involved in the participatory process.

NetSyMoD is clearly not intended to provide a single methodological approach for each and every possible application context, given the variety of situations in which public participation may be required. The emphasis is on integrating and implementing within the same framework different state-of-the-art approaches and tools for decision support: from the more traditional use of simulation models in the decision process through the development of ad hoc decision support systems, to the more innovative creative thinking approaches for participatory modelling design.

The main common components of NetSyMoD are depicted in Fig. 1, which presents also the sequence of phases and possible iterations.

[4] Body with status of legal entity under public law. managed by its members with the purpose of building,, managing and maintaining land reclamation infrastructure, including irrigation facilities.

[5] Natural resources and environmental management has been a fertile field for the application of participatory planning methodologies. A significant number of examples can be found in the works of Steelman and Ascher (1997) and Parkins and Mitchell (2005).

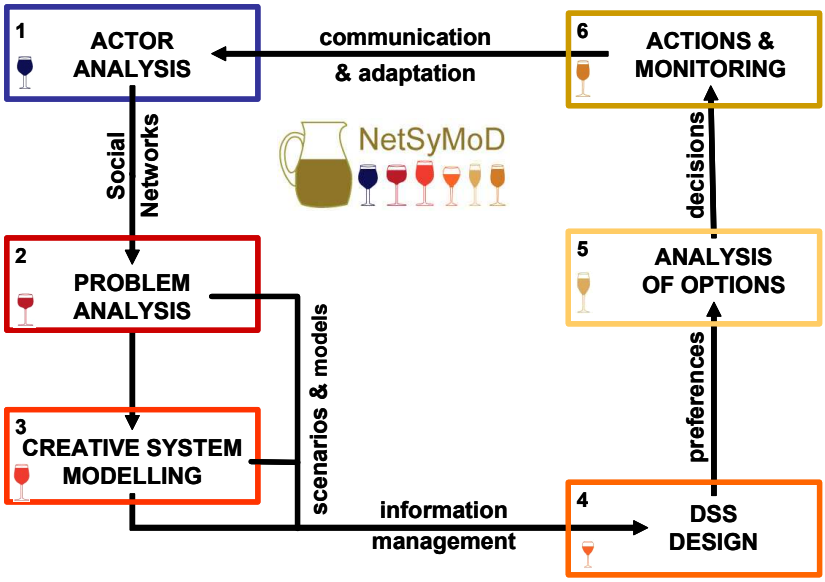

Fig. 1. Phases of NetSyMoD: Network Analysis – Creative System Modelling – Decision Support

A generic decision making process is formalised in NetSyMoD as a sequence of the following six main phases:

1. *Actors analysis*. This initial phase identifies the actors (i.e. all potential stakeholders/experts involved or affected by the decision under investigation), their relationships with the local social context and singles out those who should take active part in the decision making process.
2. *Problem analysis*. The problem (or conflict) at hand is scrutinised from various perspectives and viewpoints since different stakeholders hold different perceptions and beliefs about what are the causes of the problem or how it should be tackled. The environment in which the problem is embedded is explored and the relevant actors identified.
3. *Creative System Modelling*. Provides means for facilitating the process of participatory modelling and, more specifically, for eliciting knowledge and preferences from actors thus building a common understanding of the problem (Doyle and Ford, 1998; Huff, 1990). The key actors chosen in the previous steps of the NetSyMoD approach take part in a participatory workshop during which Cognitive Mapping techniques most suitable for the specific case are applied.
4. *DSS design*. In this phase the knowledge developed so far is used for designing the toolbox of procedures and software tools capable of managing the data required to provide informed and robust decisions in the following phase. This is necessary to manage and communicate the information flow between various process phases, including exchange, transformation, integration, validation and documentation of gathered knowledge.
5. *Analysis of Options*. It consists in the evaluation and the choice of one (or more) solutions to the problem (e.g. a policy measure, plan or project) from a set of mutually exclusive alternatives, or just the production of their complete ranking. Numerous methods and techniques have been developed in decision theory to make explicit (transparent) value judgements and assess the extent to which different options may contribute to achieve the pursued goals and objectives.
6. *Action and monitoring*. In this phase the implementation of the decisions is monitored. The techniques for monitoring the effect and effectiveness of the selected options put in practice through a certain course of action are case specific and are not systematically treated by NetSyMoD. This includes the progressive examination of the assumptions about the future development as well as the revision of the choices made upon these assumptions.

The main rationale behind NetSyMoD is that creative system modelling and participatory techniques can provide not only a common ground for mutual understanding among the parties involved, but also a scientifically sound basis for the development of effective decision support systems. DSS tools may in turn be based upon complex mathematical models, which may find in the methodology proposed an interface for easier uptake and communication with the interested public.

As demonstrated by the scientific literature, building a decision support system tool in a participatory way improves the performance of the tool, increases its acceptability – and, ultimately, the acceptability of the decisions taken with its support.

Several variants of the NetSyMoD approach have been applied so far in different contexts: integrated water resources management, agri-environmental policy, coastal management, etc. The next paragraph provides an overview of the application of the approach to the Italian case study within the EU-funded ISIIMM project, in support of a decision concerning irrigation management since the implementation of a new pressurised irrigation system is foreseen.

CASE STUDY APPLICATION AND OUTCOMES

A preliminary list of relevant actors potentially related to the issue at stake was developed on the basis of specific information collected by means of interviews to authorities responsible for on-site institutional activities.

Once identified, stakeholders have been involved by means of individual meetings, interviews and the organisation of local seminars. At first, their involvement served the purpose of collecting specific and detailed information about the needs, characteristics and problems related to water resources use and management in the area.

Subsequently, through a Social Network Analysis (SNA) (see Wetherell *et al.*, 1994), data on relations and positions of the identified actors was analysed in order to:

1. assess stakeholders' interests and influence and the ways in which those interests affect the decision-making process;
2. identify the relationships between the selected actors;
3. identify the key stakeholders to involve in the core of the participatory modelling process - a Creative System Modelling Workshop on scenario building and evaluation.

The SNA provided useful information for identifying the power relationships, the interest groups, and the main conflicts within the network of actors. Such information was obtained through semi-structured interviews.

Moreover, a list of evaluation criteria, previously consolidated by stakeholders, was submitted to all the interviewees in order to obtain a ranking of importance and subsequently select a limited number of criteria to be used in the evaluation phase.

In the Creative System Modelling Workshop on scenario building and evaluation, held in Treviso in December 2005[6], the key actors identified in the first phase reached a shared vision of the human-environmental system and a shared model of the decision problem. Future scenarios about the political and territorial situation in the area of interest in 2015 were used as contexts within which the appropriateness of the new irrigation system had to be evaluated.

The program consisted of two main sessions. In the first session three triggering scenarios (or possible futures) were presented. The three storylines gave three broad pictures representing a combination of the possible trends of key drivers considered to have important effects on water management: different degrees and methods of implementation of the Water Framework Directive and Fischler Reform of the Common Agricultural Policy and intensity of urban sprawl. These and a range of other factors such as social values and systems of governance have been used to build up the three possible futures. Such scenarios were used as tools for brainstorming on alternative futures and on long term planning with the ultimate purpose of creating a common vision of the problem related to future land and water uses in the area of interest. Cognitive mapping provided a means for facilitating the participatory modelling and surfacing actors' beliefs and preferences by using the Hodgson's hexagons approach (Hodgson, 1992) in an open discussion context.

[6] Documentation can be downloaded from FEEM's web site
http://www.feem.it/Feem/Pub/Conferences/default.htm

Fig. 2 illustrates an example cognitive map used in the workshop, referred to one of the three scenarios. In this possible future, active public policy aims to promote economic activities that are small scale and regional in scope. Local communities are strengthened to ensure participative and transparent governance. Protecting the environment and conservation of resources are strong political objectives. The Water Framework Directive is implemented only for what concerns water quality objectives. CAP reform is fully implemented. Funds available for agro-environmental measures are satisfactory and farms feel safeguarded by regional rural development policy The demand for new housing declines. The urbanisation of the countryside comes to a halt as planning controls are tightened. New buildings are located in existing towns and cities, leading to a denser urban development.

The participants were presented the conceptual model of the problem at hand integrated in the specific scenario and expressed their ideas on the possible evolution of specific nodes (irrigation, land use, water availability and water consumption).

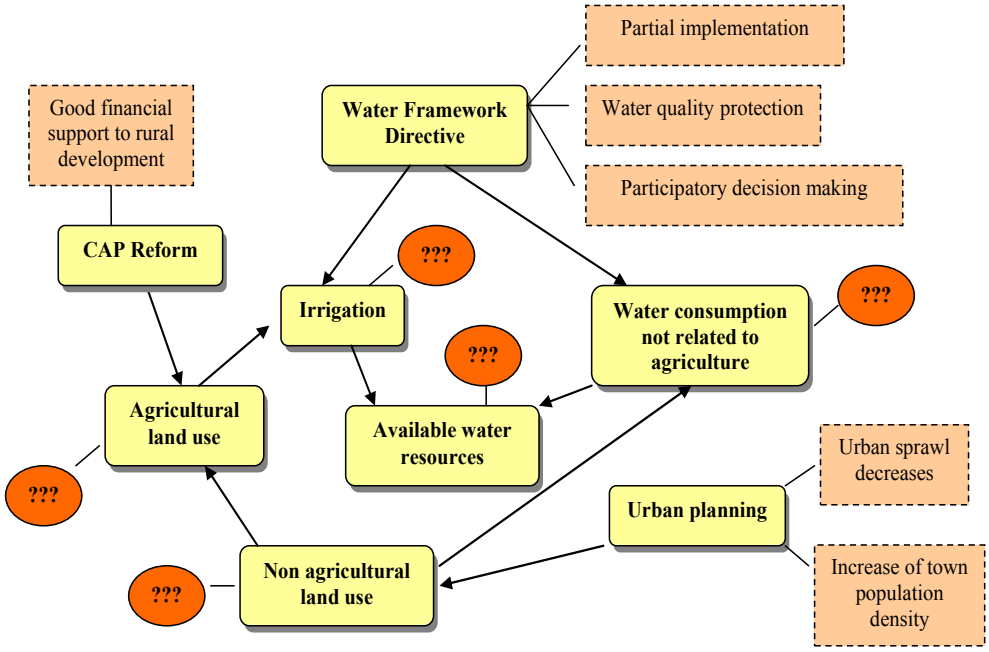

Fig. 2. Cognitive map of the problem of interest (yellow) adapted to one of the scenarios (main issues translated in the orange boxes). Question marks represent the nodes where participant's ideas or concepts were stored.

Once all participants' perceptions were collected for the three scenarios, the concepts were clustered and linked within a shared conceptual model and shown back to the group for further comments around causes and effects and to come to a shared meaning of the problem.

The scenarios were also meant to: (i) provide information of alternative future states to identify possible developments; (ii) raise awareness about connections between the above mentioned policies and water management problems; and (iii) help actors think in larger space and time scales.

The second session embraced the assessment of the irrigation system conversion project and the choice of the most plausible scenario. Information on the relative importance of the above-mentioned evaluation criteria was also assessed. Therefore, participants were asked to judge the strengths and weaknesses of the project in the light of the evolution of water and agricultural policies and the dynamics of the territory.

In order to carry out the fourth and fifth phases of the NetSyMoD approach, all collected information was analysed using mDSS (mDSS 4.0 is the current version), a software developed in a previous research project, MULINO[7] (Giupponi *et al.*, 2004; Fassio *et al.*, 2005). MDSS is a software shell providing multiple criteria analysis capabilities for facilitating the use of modelling and the participation of actors in a given decision process (Mysiak *et al.*, 2005). Through the application of Multi-Criteria Decision methods, the "best option" is identified, i.e. the solution which performs better according to the agreed set of evaluation criteria and their weights.

The option of implementing or not the project within the different scenarios was therefore evaluated against the previously agreed set of criteria: an Analysis Matrix was built and stored the performances of the alternative options evaluated for each decision criterion. Decision rules aggregated partial preferences describing individual criteria into a global preference and ranked the alternatives (Fig. 3).

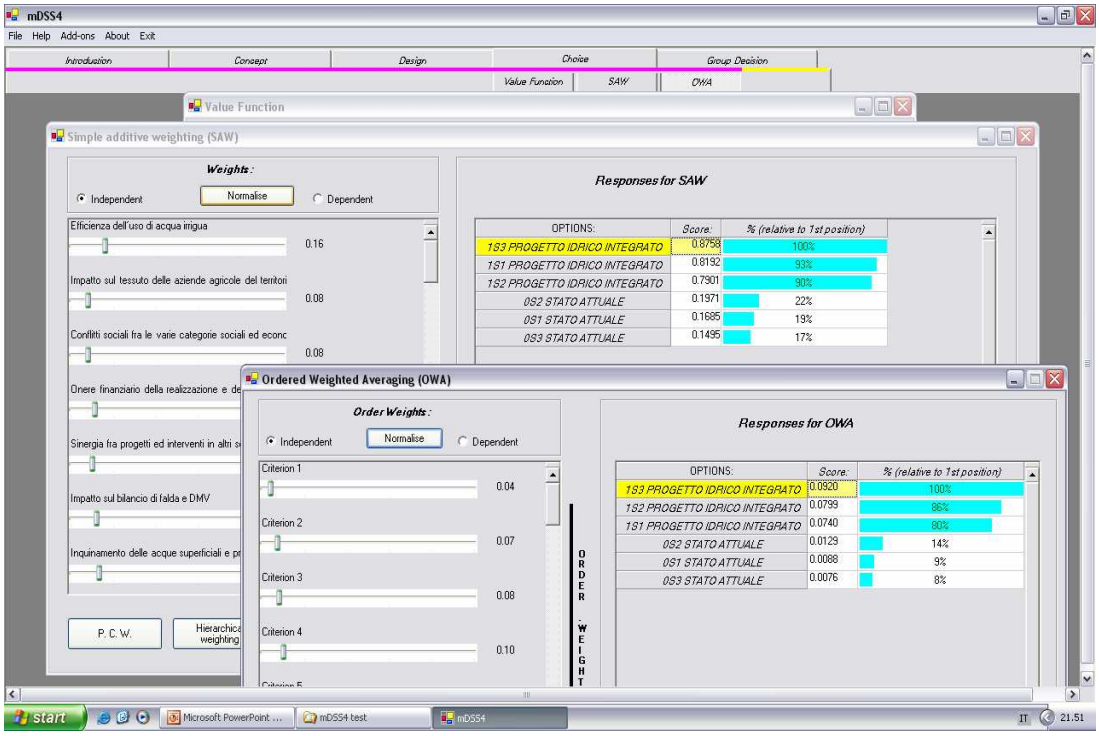

Fig. 3. Evaluation with Simple Additive Weighting (SAW) and Ordered Weighted Averaging (OWA) methods within mDSS4.

Finally, sensitivity analysis followed to examine how robust the final choice is to changes of uncertainty in indicators' values.

As a result, the outcomes of the workshop can be summarised as follows: (i) collection of opinions concerning water management from main stakeholders; (ii) collection of visions concerning possible future land and water uses in the pilot area; (iii) general agreement on the fact that water conservation measures need to be introduced; (iv) general pessimism about the future of agriculture in the area; and (v) general acceptance of the new irrigation system project, independently from future scenarios.

SUMMARY AND CONCLUSIONS

The traditional 'command and control' conception of a largely one-way 'top-down' traffic of information, where only stakeholders at the 'higher levels of action' are involved in co-designing or co-

[7]" Multi-Sectoral, Integrated and Operational Decision Support System for Sustainable Use of Water Resources at the Catchment Scale"- Project funded by the European Community under the 5th Framework Programme. Contract No. EVK1-2000-22089.

deciding, is gradually being replaced by a more reciprocal partnership among those involved in the process or, in local initiatives, even by complementary 'bottom-up' flows (where the stakeholders at the 'lower level' act as major players). The concept of 'good governance' implies that participatory processes have been established, ensuring that those who have an interest or stake in a decision can be heard and influence decision-making. New ideas, fresh approaches, and willingness to take the risk of changes are best generated and implemented in an environment where policy-making is open and transparent.

NetSyMoD is a flexible and comprehensive methodological framework, which uses a suite of ICT (Information and Communication Technology) tools, aimed at facilitating the involvement of stakeholders or experts in policy- or decision-making processes which can be formalised as a sequence of six main phases: (i) Actors analysis; (ii) Problem analysis; (iii) Creative System Modelling; (iv) DSS design; (v) Analysis of Options; and (vi) Action taking and monitoring. Several variants of the NetSyMoD approach have been applied so far in different contexts: integrated water resources management, agri-environmental policy, coastal management, etc. The various applications of NetSyMoD share the same approach for problem analysis and communication within the group of actors, based upon the use of creative thinking techniques, the formalisation of human-environment relationships through the DPSIR framework, and the use of multi-criteria analysis through the DSS software.

The NetSyMoD framework was devised primarily to facilitate the integrated water resource management, but experience shows that the framework can be applied more broadly to any other field of environmental modelling and decision making, in which an integrated approach is needed, in a public participation context.

In the ISIIMM Italian case study the approach was applied to involve key local stakeholders in the planning and evaluation phase of an irrigation system conversion project.

As a result of the first phases of NetSyMoD, a full list of stakeholders was drawn to involve them in the problem scoping. Furthermore, information on these actors was collected and a SNA carried out to determine how the social system behaves. A Creative System Modelling workshop was organised to invite selected actors to come up with a common vision of the problem and of the future evolution of the area, and to involve them in the evaluation process to reach a shared decision. A Decision Support System tool (mDSS 4.0) was then used to provide methodological and technical support to the last phases of NetSyMoD.

The results obtained constitute good ground for further discussion among participants and were useful to gain insight into the problem from other perspectives, which may then facilitate the process of decision-making, as well as encourage negotiations and help to reduce conflicts.

It can be recognized that:

1. there is a common agreement on the need to introduce water saving measures;
2. a general pessimism about the future of agriculture in the area, but the multifunctional role of farming and irrigation has been highlighted.

It can be deducted, from both the interviews and the workshop, that there is an overall agreement on the appropriateness of the restructuring of the irrigation system, independently from the evolution of the local socio-environmental system. There is therefore a general conviction that the project would contribute to the reduction of the conflicts around the Piave River.

From the ISIIMM experience it can be concluded that the process of participatory model-building can bring about substantial benefits and improvements in the management of natural resources, in terms of increased knowledge and awareness, reduction of conflicts, and easier implementation of the selected management strategies.

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