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in

Lamaddalena N. (ed.), Bogliotti C. (ed.), Todorovic M. (ed.), Scardigno A. (ed.).
Water saving in Mediterranean agriculture and future research needs [Vol. 2]

Bari : CIHEAM
Options Méditerranéennes : Série B. Etudes et Recherches; n. 56 Vol.II

2007
pages 239-248

THE NOSTRUM-DSS GUIDELINES FOR IMPROVED DEVELOPMENT AND ADOPTION OF DECISION SUPPORT SYSTEMS IN INTEGRATED WATER RESOURCES MANAGEMENT IN THE MEDITERRANEAN BASIN

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SUMMARY - Decision Support Systems (DSS) have a great theoretical potential as tools for the identification of optimal water resource management regimes in the Mediterranean basin, thus helping policy makers (PMs) to bring the principles of Integrated Water Resources Management (IWRM) into practice. However, such tools are only episodically exploited outside the academia. The Nostrum-DSS EU funded Co-ordination Action (CA) aims at contributing to the achievement of improved governance and planning in the field of sustainable water management within the Mediterranean Basin by establishing a network between the science, policy, and civil society spheres and through the development and dissemination of Best Practices Guidelines (BPGs) for the design and implementation of DSSs for IWRM in the Mediterranean Area. The scope of the project is to develop these Guidelines with the active participation of scientists, policy makers, and key stakeholders. Such participatory approach foresees the series of activities aimed at favouring efficient exchanges of information, knowledge and experiences not only within the CA. During the first year of the project, policy makers and stakeholders (SHs) informed the Nostrum-Dss scientific community with their knowledge and needs through the compilation of National Reports and via ad hoc questionnaires. During the second year the information acquired was employed to develop a first draft of the Nostrum-DSS Guidelines. Feedback from the policy sphere on the draft Guidelines is being collected through the involvement of decision makers (DMs) in local workshops. This article presents the methodological background and contents of the Guidelines, disseminated as a preliminary draft, in order to acquire feedbacks from a broader audience of interested parties.

Key words: Decision Making Process, Decision Support Systems, Integrated Water Resources Management, Participatory Approach, Water Policy, Guidelines.

RESUME – *En théorie les System d'Aide à la Décision (SAD) pourraient avoir un énorme potentiel pour l'identifier des régimes optimaux de gestion des ressources en eau dans le bassin de la Méditerranée, en venant en aide aux décideurs publics vers l'application des principes propres de la Gestion Intégrée des Ressources en Eau (GIRE). Cependant, ces outils sont utilisé que rarement en réalité et en dehors de l'environnement strictement académique. Le projet Nostrum-DSS est une Action de Coordination financée par la Commission Européenne qui a le but de contribuer à l'amélioration de la gouvernace et de la planification dans le domaine de la gestion durable des ressources en eau dans le Basin de la Méditerranée. Ce but est poursuivit à travers l'établissement d'un réseau entre les différents domaines scientifiques, politiques et de la société civile et le développement et dissémination du Guide des Meilleures Pratiques (GMP) pour la développement et implémentation de SAD pour la GIRE dans la région Méditerranéenne. Le but du projet est de développer ces Ligne Directrices avec la participation active de scientifiques, politiques et autres parties prenantes. Cette approche participative est adopté pour les activités ayant le but de faciliter un efficace échange d'informations, connaissances et expériences aussi bien en dehors de l'Action de Coordination. Pendent la première année de projet, décideurs politiques et acteurs concernés ont informés la communauté scientifique de Nostrum-DSS par rapport à leurs besoins et connaissances à travers la rédaction de Rapports Nationaux et la compilation de questionnaires. Durant la deuxième année de projet l'information obtenue a contribuée à la formulation de la version préliminaire des Ligne Directrices de Nostrum-DSS. Les opinions et commentaires sur la version préliminaire du GMP vont être recueillies à travers la participation de décideurs politiques au cours des prochains*

meetings. Cet article présente la méthodologie appliquée et les contenue de la version préliminaire des Lignes Directrices pour cueillir les impressions d'un plus vaste public.

Mots-clés : *Processus de Prise de Décision, Système d'Aide aux Décisions, Gestion Intégrée des Ressources en Eau, Politiques de l'Eau, Lignes Directrices.*

THE NOSTRUM-DSS PROJECT

The Nostrum-DSS project (Network on Governance, Science and Technology for Sustainable Water Resources Management in the Mediterranean. The role of DSS tools) is a three-year (2004-2007) Co-ordination Action funded by the European Commission under the Sixth Framework Programme which involves eighteen partners from the North and South shores of the Mediterranean Basin.

The Mediterranean is strategically located between different sets of cultures, different development choices, often dividing them. However, in its historic role, the Mediterranean used to be a unifying element between those different, but intrinsically interconnected, worlds.

Water resources are scarce in the Mediterranean area, and yet the current management regimes are at times neither efficient nor sustainable. The need to improve on the current system is paramount, if the objective of sustainable development and stability in the region, are to be achieved and maintained, as declared in many official documents and international agreements.

Decision Support System (DSS) are instruments that have an enormous potential as tools for the identification of sustainable water resource management regimes in the Mediterranean basin, where water resource scarcity could prove a contributing factor to conflict and instability (Bettinger *et al.,* 2001; Walker *et al*., 2001). DSS tools can help to design management strategies which are flexible enough to accommodate changing political and socio-economic situations as well as technological innovations, but, at the same time, strict enough to ensure the ecological sustainability of water uses (Huang *et al*., 2001; Bhaduri *et al*., 2000). In the whole Mediterranean region there is a significant lack of a clear effort towards the development and dissemination of information and knowledge on DSS for water management. The Nostrum-Dss report on the state-of-the-art of DSS tools has shown how there are no examples of operational decision support systems for IWRM in the Mediterranean Basin (Fedra, 2006). DSS' potentiality is too often not exploited because of a lack of interaction between policy makers and researchers: on the one hand, researchers are often not responsive to the needs of policy makers; on the other hand, policy makers have a tendency not to use scientific information for the formulation of water resources management policies.

The ultimate aim of the Nostrum-DSS project is therefore to bridge the gap between policy makers and researchers with respect to the use of DSS tools as instruments for improving governance for IWRM in the Mediterranean basin, in order to provide policy makers with a set of tools based on an integrated approach for solving different emerging national and transboundary problems in water management.

Nostrum-DSS CA is adopting a multi-sectoral and multi-disciplinary approach, by considering the possible applications of DSS tools in various sectors (agriculture, industry, tourism, urban areas) and the different aspects that a DSS should take into account for supporting IWRM (technological, environmental and socio-economic aspects).

The final outcome of the CA is a set of Best Practices Guidelines (BPGs) for the design, development and implementation of useful DSS tools for IWRM. The BPGs are being developed with the active involvement of the relevant decision makers (DMs) and stakeholders (SHs) in the different stages of the project. To this aim, PMs, DMs and SHs have been involved since the early beginning of the project by informing the scientific community of the Nostrum-DSS' Consortium with theirs knowledge and needs. National Reports (NR) were prepared by each participating country and subsequent meta-analysis on the NR were carried out. These steps have allowed the identification of best practices, common pitfalls and mistakes in water management practices, in stakeholders' involvement and in the development and implementation of DSS tools.

During the second and third year of the project implementation, the organisation of ad-hoc sessions during local technical workshops (Tunisia, Egypt, Cyprus, Italy) allows the participation of relevant decision makers who contributed to define the preliminary structure of the Guidelines. The agreement on the final version of the Guidelines will be reached thanks to the elaboration of the Consensus Document in the Final Dissemination Conference in Cyprus and last Steering Committee Meeting in November 2007.

In order to disseminate the outcomes, the whole set of project's products will be made available on the web trough an interactive 3D structure, called Nostrum-DSS Meta-Guidelines (NDMG). Such structure was named meta-guidelines in analogy with the definition of metadata to express a concept of documentation and facilitation of access to a broadest collection of information potentially useful for guiding the development and implementation of DSS tools. Information collected comes first of all from the documentation developed by the Nostrum-DSS CA, but also from pre-existing guidelines in the field of IWRM and similar documents, papers, reports.

In order to facilitate the uptake of the Nostrum-Dss products, the information gathered and stored in the NDMG, converges and is summarized in the Nostrum-DSS the Guidelines (NDG), a brief document deigned to guide the user to the whole set of information and knowledge collected during the project activities.

The next sections of this article present briefly both the preliminary structure and the contents of the Guidelines and related project outputs.

OVERVIEW OF THE STRUCTURE AND CONTENTS OF THE GUIDELINES

The project attempts to inform policy makers about the potential and actual uses of DSS. At the same time, Nostrum-DSS is trying to advance the knowledge and understanding of particular aspects of DSS approaches and technologies, which can be particularly useful for policy making on water resource uses. This should create an enabling environment for an increased use of appropriate DSS tools for IWRM in the Mediterranean, which should ultimately lead to significant improvements in water resource uses (Bower, 2000). The whole set information and document, produced during the Nostrum-DSS project, with the involvement of stakeholders, scientists, policy and decision makers will be made available on the net through a web based user friendly interface.

The Best Practices Guidelines (BPG) will be the core part of a practical tool, the Guidelines, aiming at improving the dissemination of knowledge for and effective implementation of a water policy or management process. This document represents the most important component of the concept of "meta-guidelines" developed by the Nostrum-Dss CA. As previously stated, the "meta" prefix identifies the emphasis put in facilitating access to information and avoiding duplications of previous efforts (i.e. previously published guidelines, toolboxes, manuals, etc.), preferring instead to build upon already existing materials and facilitating a guided access to available resources with increasing levels of details, starting with very concise documents, such as the NDG, executive summaries, summaries for policymakers, and similar.

The NDG are designed on the information collected and the needs expressed by the interested parties participating at project's local workshops and through the compilation of ad-hoc questionnaires. From the early beginning, the Coordination Action has been based on the involvement of PMs and SHs. The information gathered during the meetings and the compilation of the National Reports and focusing on the needs for an improved use and development of decision support systems and enlightening problem areas emerging during the design and implementation of an IWRM policy process are included in the Guidelines. Particular importance is given to needs emerging during each phase of the process' implementation also concerning the limited resources and capacities that institutions have to cope with, as well as on the perceived inadequacies of tools' features to be overcome for an easier and effective development and application of DSS in the Mediterranean area.

The NDG document is structured in two linked sections (A and B), plus annexes. The first part is designed as a set of practical checklists identifying needs and problem areas emerging during the development and implementation of a water policy plan or decision process. Section B instead

provides good practice recommendations stressing on issues related to the improvement of decision support tools' development and use in the field of water management. Moreover, this second part aim at responding to the needs expressed in section A through recommendations and refers to a third part annexed to the document, a component of the NDMG, which includes links to other briefs, manuals guidelines, tools, approaches and methods.

Both sections of the document present the same structure. An introduction is followed by 3 chapters corresponding to the main phases identified in the design of a policy or management strategy ("Actor and Problem Analysis", "Policy/Decision Design" and "Policy/Decision Choice"). The NDG aims at guiding policy and decision makers by providing step-by-step responses to the needs surfacing in the experience of carrying out the different phases of an IWRM process. Therefore, the Guidelines are structured as a practical tool conducting the user in the consultation of the project's outcomes and of the other previously published products (guidelines, methods, approaches and references to existing decision support tools) selected through an ad-hoc review described below in this article. As mentioned before, the whole set of products is gathered and organized in a 3D web-based tool illustrated in the next section.

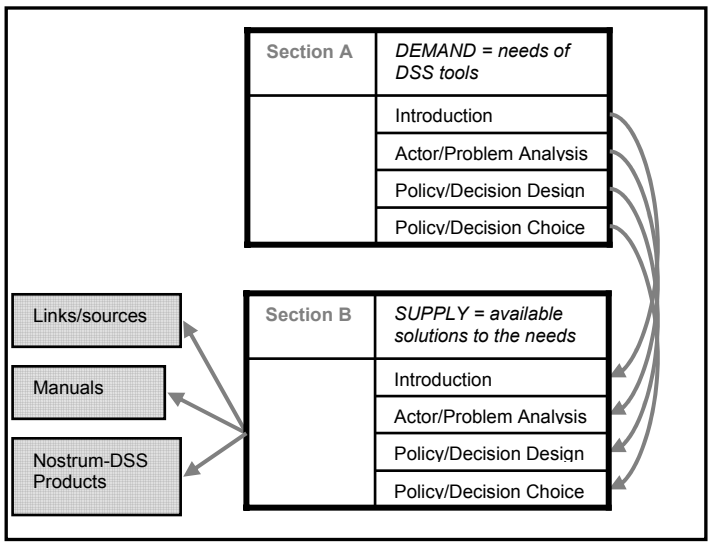

Fig.1. The structure of the Guidelines.

The project's case studies described in the National Reports are extracted and made available in a concise and schematic form following the structure of the Guidelines' sections. They offer actual examples of pitfalls but also best practices, successes and failure encountered during the implementation of a policy or management process in the partner countries.

The final version of the Guidelines integrates the information contained in the Scientific Guidelines which represent the draft version of the final document and the final product of the Coordinated Action, the BPGs. The Scientific Guidelines integrates the main information included in the documents produced by the relevant EU projects or organizations engaged in research activities for improved governance in the field of the water resources management. An ad-hoc review has been carried out to collect these documents and is described below in the article.

The comments and observations collected during the Science and Policy Workshop (February 2007, Bari, Italy) and the following meeting in Lebanon (spring 2007) will contribute to the definition of the structure and content of the Guidelines and converge in a Consensus Document. Then Final Dissemination Conference, to be yield in Cyprus in September 2007, will involve a large number of participants from the scientific and policy sphere and lead to the definition of the final version of the BPGs.
Summarizing the main contents of the project's products and the relevant other sources of information selected, the Guidelines become a practical guide to the exploration and search of the various items available in the Meta-Guidelines.

THE WEB STRUCTURE OF THE META-GUIDELINES

The overall structure of the NDMG is conceived as a 3D web based tool, developed upon a series of layers taking the user to the whole set of products (such as glossaries, briefs, guidelines, deliverables, case studies, data and alternative sources) as shown in Figure 2. The structure hosts materials targeted to policy makers and water users and available on various interconnected layers. The material forming the core part of the Meta-Guidelines is constituted by products both worked out under Nostrum-DSS project and gathered through a specific review carried out in the context of other projects and initiatives. First of all, the main deliverables of Nostrum-DSS project are the knowledge base of the NDG and NDMG. A comprehensive list of these documents is provided in *Table 1* in the appendix. It is worth mentioning that, as agreed within the project Consortium, the main findings of the thematic Nostrum-DSS reports are summarized in Policy Briefs. This in order to provide the final users of the Nostrum-DSS outputs with an effective toolbox.

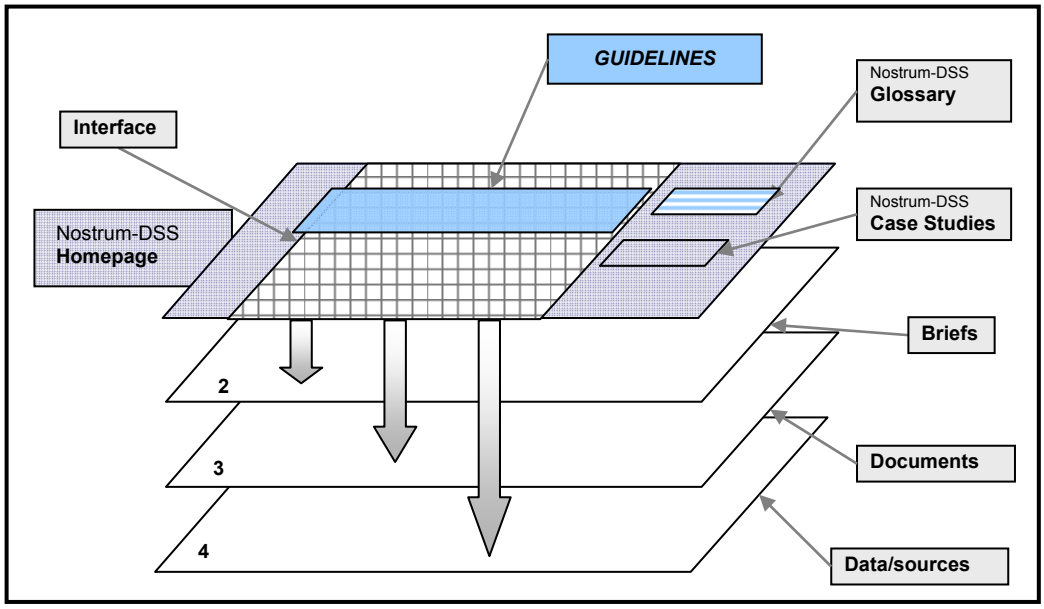

Fig.2. The 3D structure of the Meta-Guidelines.

The first level of the Meta-Guidelines consists of a matrix (Fig. 3) appearing on the homepage of the project web-site. The matrix aims at simplifying the user interface to the whole 3D structure, guiding him/her in the search of the relevant information gathered and organized in the NDMG. Rising from the project purpose of identifying and supplying the policy and decision makers' needs surfaced during the implementation of the different steps of the IWRM, the matrix has been outlined on 6 main phases of the decision process (columns). The lower rows of the matrix correspond to the deeper levels (2, 3 and 4) of the 3D structure.

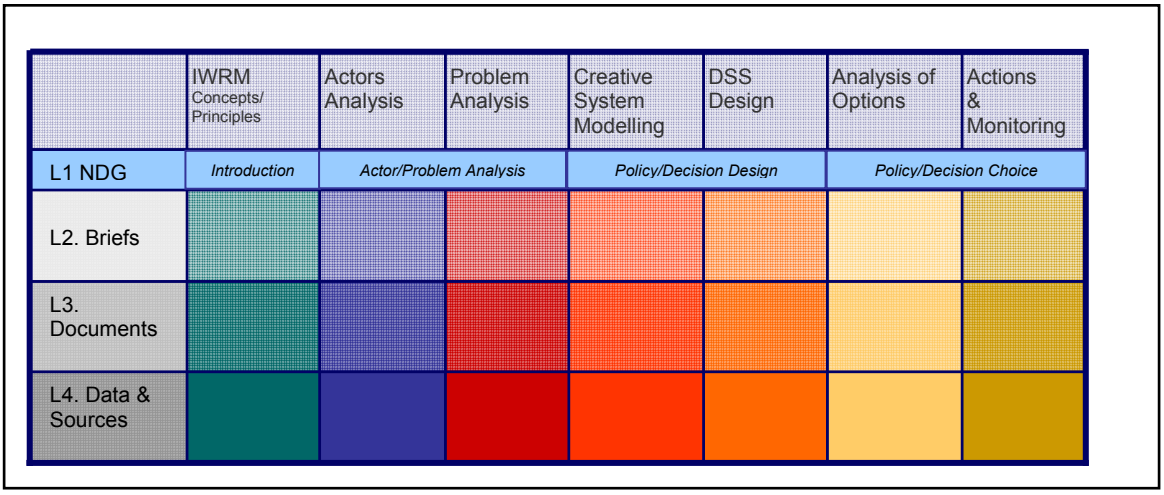

Fig. 3: The Matrix, interface of the 3D structure of the Nostrum-DSS Meta-Guidelines

Through the table's cells the user gains access to the materials gathered in the levels below, and categorised according to the six main keywords. Consistently with the structure of the NDMG, the 2nd level of the structure hosts briefs (such as good practice recommendations, policy briefs and technical notes); into the 3rd level are stored extended documents (such as reports, handbooks, manuals, articles and deliverables); and in the 4th level case studies and data are available.

Some of the products aim at giving general advices on how to implement the whole IWRM process or parts of it. Other documents address the issue at stake by trying to guide the PMs in the technical aspects of the development, implementation and monitoring of an appropriate water management plan. For example, manuals or tool-boxes are available to initiate the user into the comprehension and application of adequate methods and approaches that should support in solving a range of management problems.

Every layer depicted in Figure 2 is accessible through a vector composed as a row of active cells in the interface matrix. Every cell is labelled by a keyword selected as describing fundamental elements related to the implementation of each phase of the policy/decision water process and related to the three main phases adopted as sections of the NDG.

In the frame and for each of the seven components or management steps, a comparative analysis between the sections of the documents gathered has been carried out to quote the relevant information included. This work yielded to the elaboration of the scientific guidelines, i.e. the NDG, available to the user on the upper level of the NDMG. In the interface matrix, the NDG described in the previous chapter are split into the 4 main chapters, namely "Introduction", "Actors/Problem Analysis", "Policy/Decision Design", "Policy/Decision Choice", each including both sections A and B.

The NDG are indeed envisaged as scientific guidelines, but also the entry door to the products of the whole CA, but also to a much broader resource environment, that can be accessed through a system of web links, active when the Guidelines are consulted from the Nostrum-Dss web site, but also after local downloads of the pdf version.

As mentioned before, an extended review has been carried out to identify the relevant knowledge produced in the context of Nostrum-DSS related projects and, international or regional institutions and organizations. This fed into the definition of the structure and content of the scientific guidelines. Besides, the links to all documents gathered, with the indication of the pages where to find the pertinent information to the specific procedure phase and keyword, are made available through the NDMG. The next chapter is dedicated to the description of the review.

THE REVIEW

At the early beginning, the review focused on the investigation of the main downloadable results produced by clusters of projects or single projects linked to Nostrum-DSS and funded by the European Commission. Relevant EU projects taken into account were: “HARMONICA” (Harmonized Modelling Tools for Integrated Basin Management), “HARMONICOP” (Harmonising Collaborative Planning), “TRANSCAT” (Integrated Resources Management of Transboundary Catchments), “NEWATER” (New Approach to adaptive water Management under Uncertainty), “MULINO” (MULti-sectoral, INtegrated and Operational decision support system for sustainable use of water resources at the catchment scale), “WATERSTRATEGYMAN” (Developing Strategies for Regulating and Managing Water Resources and Demand in Water Deficient Regions) and “EMPOWERS” (Euro-Med Participatory Water Resources Scenarios). Afterwards, the research analysed the available material from the web-sites of some of the most representative International Institutions engaged in the achievement and assertion of the IWRM’s basic principles, such as UNESCO, OCED, GWP, FAO, CGIAR and the World Bank.

Other sources considered were information available on the knowledge exchange tool EMWIS/SEMIDE (initiative funded under the Euro-Mediterranean Partnership) and the documents targeted to assist the PMs on special issues drafted by national governmental institutions. National and Trans-national projects developing Decision Support Systems are also included in the review (e.g. Elbe-DSS). The search of relevant scientific articles is carried out into some “web delivery systems” (e.g. Science Direct: http://www.sciencedirect.com/), making use of keywords. According to an approximate estimation, the review will lead at the gathering of almost 200 products.

CONCLUSIONS

Overall, the Nostrum-DSS Guidelines, and specifically the interactive matrix on the web should support the decision makers to find possible solutions and reasonable responses to the needs they face during the implementation of the IWRM principles. Altogether, the approach adopted to design the Guidelines carries out an exploration of one side of the question relative to the DSS’ design, development and implementation: the domain analysing what a DSS tool should consider to effectively assist the decision process. This phase in carried out through the identification of the PMs’ needs that, subsequently, should be taken into account by the DSS developers in the Information Technology domain during the concrete development of these complex tools. Then the design of the Guidelines will be linked to different kinds of existing models and information tools, possibly interfacing with a DSS, available to supply the specific needs identified for policy makers.

Through this net, the identification of a set of adequate information tools could provide the software developers with precious and concrete advices for the development of more effective DSS tools. The appropriate realisation of a DSS should lead to an effective and wide application of these tools in the decision making process and, even at present, the way the matrix is conceived could provide an important contribution to the achievement of this goal.

The structure of the Guidelines presented in this article is still preliminary and it will be agreed upon during the Science and Policy Workshop (Bari, Italy February 2007) where stakeholders’ involvement will be reached and the needs of civil society on IWRM will be more clearly acknowledged and comprehensively addressed by policy makers and researchers.

The policy makers and stakeholders opinions collected during this Workshop will flow into the final version of the BPG that will be finalised and then disseminated during the Nostrum-DSS Final Dissemination Conference (November 2007, Cyprus).

This strategy aims at ensuring that governmental and non-governmental institutions involved in the Nostrum-DSS CA, be aware of the relevance, both political and socio-economic, of the key role of public participation in defining and implementing water management strategies.

Acknowledgments

The Guidelines are developed within the framework of the NOSTRUM-Dss Project ("Network on gOvernance, Science and Technology for sustainable water ResoUrce management in the Mediterranean. The role of DSS tools », a Coordination Action funded by the European Commission Contract no. INCO-CT-2004-509158), within the sixth framework programme, and contributing to the implementation of the Key Action "specific measures in support of international cooperation" - Mediterranean partner countries (MPC), 2004-2007. Several other synergic contributions came from other grants, in particular from the HarmoniCa Concerted Action (http://www.harmoni-ca.info/).

Appendices

Table 1. List of Nostrum-DSS' Deliverables

Deliverables Number	The main products of Nostrum-DSS Co-ordination Action
D2-1	Report on water uses in agriculture in the Mediterranean Countries
D2-2	Report on industrial water use in the Mediterranean Countries
D2-3	Report on urban and tourist uses and engineering of the water cycle in the Mediterranean Countries
D2-4	Report on multisectoral approaches to Dss uses in water management
D3-1	Report on economics of the water cycle in the Mediterranean Countries
D3-2	Report on social issues in water management in the Mediterranean Countries
D3-3	Report on environment and the water cycle in the Mediterranean Countries
D3-4	Multi-disciplinary report on approaches to decision making and IWRM
D4-1	Survey of relevant information centres and data sources for statistics and socioeconomic data
D4-2	Survey of relevant information centres and data sources for geographical data
D4-3	Report about future scenarios on the climate changes in the Mediterranean and the Expected consequences on water resources
D4-4	Meta-data analysis
D5-1	Glossary of IWRM terminology used by different disciplines and methodologies
D5-2	Report of the scientific guidelines for Dss design and implementation
D5-3	Best Practices Guidelines
D5-4	Feasibility analysis and communication techniques
D5-5	Report on development and implementation of Dss tools in the Mediterranean Area
D6-1	Consensus document
D6-2	Comparative assessment of decision making processes, regulations and laws, in the Mediterranean Countries
D6-3	Report on the development of agent based models for water demand and supply
D6-4	Training material for policy makers
D6-5	Thematic report on governance for IWRM
D6-6	Thematic report on social aspects of conflicting water uses
D6-7	Thematic report on Dss and stakeholders' participation

REFERENCES

Bettinger, P. and Boston, K. (2001). A conceptual model for describing decision-making situations in integrated natural resource planning and modeling projects. *Environmental Management*, 28(1): 1–7.

Bhaduri, B.; Arbor, J.; Engel, B., and Grove, M. (2000). Assessing watershed-scale, long-term hydrologic impacts of land-use change using a GIS-NPS model. Environmental Management, 26(6):643–658.

Bouwer, H. (2000). Integrated water management: emerging issues and challenges. *Agricultural Water Management*, 45:217-228.

Fedra, K. (2006). Report on development and implementation of DSS tools in the Mediterranean Area. Nostrum-DSS project's Deliverable D05.5

Gregory, R. and Wellman, K. (2001). Bringing stakeholder values into environmental policy choices: a community-based estuary case study. *Ecological Economics*, 39:37–52.

Gu, J. and Tang, X. Designing (2000) a water resources management decision support system: an application of the WSR approach. *Systemic Practice and Action Research*, 13 (1).

Hämäläinen, R. P.; Kettunen, E.; Ehtamo, H., and Martunnen, M. (2001). Evaluating a Framework for Multi-Stakeholder Decision Support in Water Resources Management. *Group Decision and Negotiation*, 10: 331–353.

Huang, G. H. and Xia, J. (2001). Barriers to sustainable water-quality management. *Journal of Environmental Management*, 61:1–23.

Thornett, A. M. (2001). Computer decision support systems in general practice. *International Journal of Information Management*, 21:39-47.

Walker, D. H.; Cowell, S. G., and Johnson, A. K. L (2001). Integrating research results into decision making about natural resource management at a catchment scale. *Agricultural Systems*, 69: 85-98.