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NOSTRUM-DSS

NETWORK ON GOVERNANCE, SCIENCE AND TECHNOLOGY

FOR SUSTAINABLE WATER RESOURCE MANAGEMENT IN THE MEDITERRANEAN.

THE ROLE OF DSS TOOLS

INSTRUMENT: Co-ordination Action

THEMATIC PRIORITY: INCO-MPC, Specific measures in support of international co-operation - Mediterranean Partner Countries (MPC)

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Report of the scientific guidelines for Dss design and implementation

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AUTHORS: YAELLA DEPIETRI, CARLO GIUPPONI	

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Table of Contents

This document presents the Guidelines for the development and application of Decision Support System (DSS) tools in response to the needs of policy makers in the field of Integrated Water Resources Management. These Guidelines have been 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/).

The present version of the Guidelines has been developed for dissemination within and outside the Nostrum-Dss Consortium, in order to collect feedbacks from researchers and policy makers involved in various ways in the Coordination Action.

A final version of this draft will be presented at the final Nostrum-Dss Conference and disseminated through the project web site.

Introduction

The aggravation of water scarcity problems has led to an increasing competition between different water uses and users. The need to adopt an integrated approach to water management has been developed and affirmed principally through the "International Conference on Water and the Environment" held in Dublin (1992), the "UN Conference on Environment and Development", Rio de Janeiro of 1992, the United Nations Millennium Declaration (2002) the "World Summit on Sustainable Development", Johannesburg 2002.

According to the definition provided by the Global Water Partnership (GWP), Integrated Water Resources Management (IWRM) "is a process which promotes the co-ordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" (GWP-TAC, 2000). In reforming traditional water policies or in the design of innovative management strategies, multiple conflicting criteria, perceptions and objectives have to be taken into account and integrated.

Decision Support Systems (DSS) have a strong potential as tools for the identification of water resource management regimes in the Mediterranean Basin, where water resource scarcity contributes to social conflicts and political instability (Bettinger et al., 2001; Walker et al., 2001). In particular 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, and strict enough to ensure the ecological sustainability of water uses (Bhaduri et al., 2000; Huang et al., 2001)

Within these Guidelines DSS refer to a wide range of computer-based tools (simulation models, and/or techniques and methods) developed to support decision analysis and participatory processes in the water management sector.

As evidenced by the studies conducted by the Nostrum-Dss Coordination Action (CA), in the Mediterranean region there is a significant lack of a clear effort towards the development and dissemination of information and knowledge about the potentials of DSS for water management. A dedicated report on the state-of-the-art of DSS development and applications (Fedra, 2006), and the surveys conducted in 14 Mediterranean countries (http://www.feem-web.it/nostrum/doc/d2-4_rev.pdf) have shown that there are very few examples of operational DSSs for IWRM in the Mediterranean Basin.

The Scientific Guidelines' aims and contents

The main purpose of the Guidelines is to contribute to the improvement of water governance in the Mediterranean area, by assisting policy and decision makers in the development of water policies and management plans. Furthermore, the Nostrum-Dss CA, and this document in particular, aim at filling the gaps between the needs of policy/decision makers and the methods and tools developed by the scientific communities for the management of water resources. Users' needs emerging during the development of sustainable water policies and plan implementations, and the obstacles towards the adoption of effective decision support systems for IWRM have been identified and analysed throughout the Nostrum-Dss activities and compared with the existing international literature. The main outcomes of those activities have been synthesised and phrased in the form of concise recommendations for the development and application of more effective DSS, that could be useful for both the scientific and the policy makers' communities. The former could find insights into the needs for operationalising the theoretical principles of IWRM, while the latter could find clarifications about what the approaches based upon the use of DSS tools can offer.

How to use the Guidelines

The Scientific Guidelines are designed as an interactive tool to facilitate the consultation of the project's outcomes and other related products. Their purpose is to guide the user in the search for possible solutions and reasonable responses to the needs users face during the implementation of the IWRM. The document is structured in two linked sections, as shown in figure 1. The first section contains untitled "Best Practices Guidelines (BPGs) for the development and application of DSS tools". It is designed as a set of practical checklists, providing good practice recommendations stressing the issues related to the improvement of decision support tools' development and use in the field of water management. It responds in detail to perceived inadequacies concerning the development and the support offered by DSS for the accomplishment of a particular management task. The second section, "Policy Background", identifies policy targets and problem areas for the development and implementation of water policies or decision processes. Stakeholders' needs are listed here in terms of tasks to be accomplished or goals to be attained towards the implementation of the IWRM process.

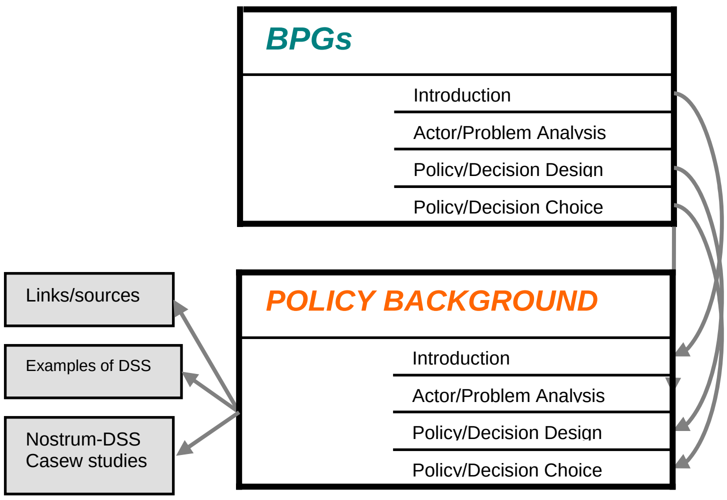

Figure 1. *The structure of the Scientific Guidelines*

Both sections present an introduction followed by 3 chapters which correspond to the main phases encountered in the design of a policy or plan: "Actor and Problem Analysis", "Policy/Decision

Design" and "Policy/Decision Choice". A description for most of these terms can be found in the Nostrum-Dss Glossary (http://www.feem-web.it/nostrum/doc/d5-1_rev.pdf).

As depicted in Figure 1, the Guidelines are designed as a stand-alone component, but they are embedded within a more complex structure which will constitute the contents of the Nostrum-Dss web site, after the completion of the project, shown in Figure 2. This document represents the most important component of a concept of "meta-guidelines" developed by the Nostrum-Dss CA. The "meta" prefix identifies the emphasis placed on 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 executive summaries, summaries for policymakers, and so on.

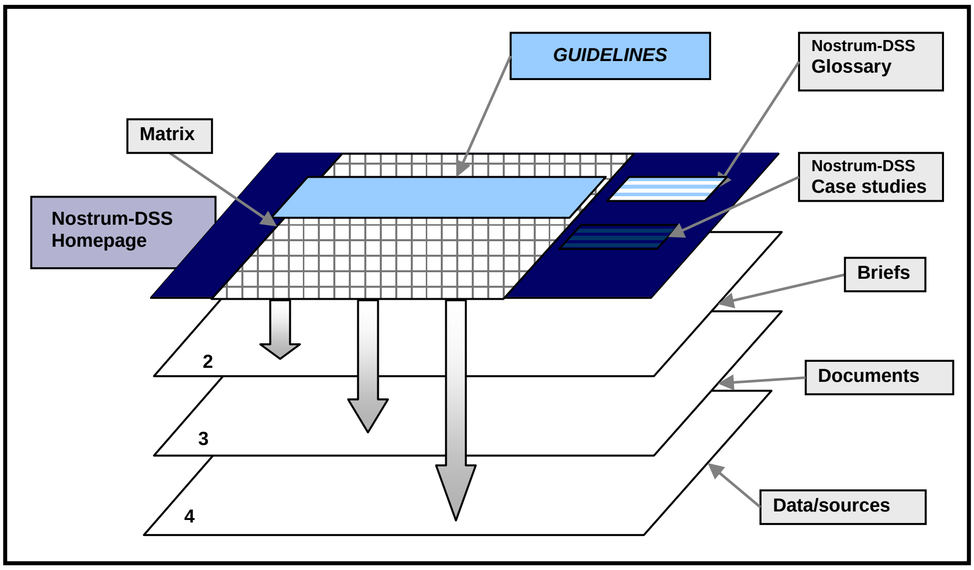

Figure 2. *The structure of the Meta-Guidelines*

The Guidelines are indeed envisaged as 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, which are active when the Guidelines are consulted from the Nostrum-Dss web site, but also after local downloads of the pdf version.

The user can access the available documents (briefs, manuals, guidelines) by selecting on the various "link" in the first section of the Guidelines. Some examples of the tools are shown in **box 1** by clicking on the interactive link, while the summaries of the case studies presented in the Nostrum-Dss National Reports can be obtained by clicking on the interactive names of the countries listed in **table 1**. All this material is collected in the three annexes ANNEX 1: "Links and further readings"; ANNEX 2: "Examples of existing DSS for different domains related to water resource management"; ANNEX 3: "The Nostrum-DSS case studies extracted from the National Reports".

The final version of the Guidelines will be made available in html format to be consulted online from the homepage of the project's web site and will be linked to the products gathered in the Meta-Guidelines. A pdf version of the document, containing dedicated sectors for links, sources and references, will also be downloadable directly from the web.

BEST PRACTICES GUIDELINES (BPGs) for the development and application of improved DSS tools

Introduction link1

1. ***The mobilisation of international and domestic financial resources at all levels should be accompanied by technology transfer, the promotion of best practices and support for capacity building as stated by the "WSSD Plan of implementation (IV (a))" (UN, 2002).***

- This is necessary to set up a favourable environment for the development and acquisition of effective information and communication tools (i.e. DSS) in support of actions aimed at implementing action towards the WSSD (i.e. the development of IWRM) and MDGs targets (i.e. Water Supply and Sanitation).

2. ***Different priorities and objectives of stakeholders and researchers are the main causes of the existing gaps between the two spheres***.

- In this context, an **enhanced communication** and collaboration between scientists and policy makers could play a central role (Acreman, 2005).
- Networks of scientists, PMs and stakeholders should be created to improve communication and participation of all significant actors involved in the decision-making process. Networks facilitate the exchange of experiences and knowledge between different Institutions.

3. ***It is necessary to adapt tools to the users' needs and not vice-versa.***

- **Scientists should give direct answers to specific questions**. On the other hand, policy and decision makers should strengthen their institutional and technical capacity in integrating scientific knowledge and in adopting the proposed tools.
- DSS tools should assist the work of end users: the tools may be more effective if they provide outputs specifically designed to meet the formal requirements of the administration.

> "Integrated water resources management with strong stakeholder participation, a pro-poor emphasis, and gender sensitivity is a key approach to ensure the integration of water services within an overall water management framework." (EUWI, 2005)
>
> **The EUWI– Research Component**

> "Models and modelling – from conceptual to high resolution numerical types - are increasingly essential tools with which to address the complexity of managing water resources at ecosystem scales" (Gyawali et al., 2006)
>
> **The EUWI– Research Component**

- The **institutional mandate of the system's user** (what decisions users can and have to make, and on the basis of which information) and the internal rules and practices within the organisation, relation to other institutions **should be carefully investigated and clarified**. **DSS may impose some degree of change**. These risks may be reduced by actions targeted to **provide timely and effective communication,** including the anticipation of possible changes to be expected from the DSS implementation.
- The development of a DSS tool specific for the application in a decision case should adequately consider what the **constraints** could be towards its practical implementation.

4. ***It is at the river basin scale that hydrologic and socio-economic relationships can be reasonably integrated in a comprehensive modelling framework for the design of a more rational use of water resources (McKinney, 2004).***

- Adopting a holistic approach to water resources management means that different water uses and multiple time and spatial scales have to be integrated. Integration is made at different levels including both natural and human systems: fresh water and coastal zone; surface water and groundwater; land and water as well as upstream and downstream uses management; water quantity and quality (GWP-TAC, 2000).
- **Integrated simulation and optimization approaches, as DSS, can provide a proactive tool for system integration.** Thus, models should be detailed enough to be adapted to the particular watershed features
- Decision support systems in the field of water management have to integrate different knowledge domains and support different roles. The quality of the DSS results is determined by the quality of the decision processes and the usefulness of the outcomes depends on the quality of the communication strategy. **The choice and inclusion in the modelling process of what is perceived as relevant knowledge and the way how this choice is made is crucial**.
- Models should be detailed enough to be adapted to the particular watershed features.

> "IWRM is critical in achieving many of the MDGs. Inherent in the concept of IWRM are the principles of:
> - water use efficiency;
> - balance of competing uses;
> - the application of all environmentally sound technology;
> - participatory planning and implementation."
>
> (UN-Water, 2006)

Actor and Problem Analysis link2

5. ***Supporting the decision process also means making knowledge accessible and easy to understand. Decision support systems could play an important role in participatory and deliberation processes.***

- **Decision support tools can make communication and elicitation of the different stakeholders' perspectives easier by** supporting interactions between stakeholders. Excessive complexity of the DSS' user interfaces or language constitutes an important limitation to the system's uptake. DSS should be developed taking these needs into account: for instance by providing functionalities for managing the access to information and involving focus groups, or by providing multi-lingual interfaces.
- Both the DSS development and the decision process should be readily adapted to the intended users' needs. Building up fora and councils of stakeholders to assure public participation in the management/planning process and **early involvement of the intended users in the tool development** is one of the most critical success factors. "When the user gets clearer insights into the problem, it helps him or her to communicate" (Gedolf, 2004).
- **Trust by intended users is often a problem for DSSs and models** mainly because system features are not understood or because of hidden uncertainties contained in embedded knowledge. A DSS should be developed to allow its interactive control directly by the user or through a facilitator. "To be successfully adopted a DSS should be based on solid scientific bases" (Hare, 2004). Involving stakeholders in model-building (**participatory modelling**) ensures a certain degree of transparency and confidence of users in the tool.
- **Adapted and user-friendly interfaces**, hiding part of the technical systems' complexity, are of fundamental importance for an easier and successful uptake of the system. "Finding a balance between system complexity and the features of the good enough modelling tools for management and participatory purposes is the goal" (Hare, 2004).

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6. ***Stakeholder analysis, social network analysis and conflict assessment are features often required in DSS systems, or in tools to be integrated with them.***

- Robust methods are needed for supporting social analysis, given the relevance of that dimension for the design of policies and implementation of plans that may be accepted by the interested

> "For models to be useful in the pursuit of sustainable solutions, they must address and simulate not only technical merits and overall benefits and costs, but also the preferences and priorities of stakeholders. To be truly useful as decision support tools models needs to be integrated into the local institutional and cultural context." (GWP-TAC, 2004)
>
> **The Global Water Partnership (GWP)**

communities. Group decision-making functionalities are also often needed to implement the preferences of different actors in the choice phase.

7. ***The adoption of a DSS tool should be done with a specific emphasis on clarifying whether or not sufficient human and financial resources could be available.***

- Political, legislative, institutional and technical resources and constraints are evaluated and taken into account since the beginning of the decision-making process.
- Financial resources could also be needed, for example to consolidate the available data sets.
- Authorities and water organization should reinforce their technical capacity in using decision support tools.
- "However, the use of DSS should not exclude the application of traditional tools to avoid discrimination especially in regions where many people do not have access to the internet or are not familiar with the use of computers"(Maurel, 2003).

8. ***The introduction of socio-economic analysis is necessary but socio-economic models are rare, compared to the hydrological ones.***

- Economic analysis comprises: the economic analysis of water uses; the development of a baseline scenario, the analysis of the current level of recovery of costs of water services and the cost effectiveness analysis.
- "There is a **lack of confidence in models that include social elements** mainly due to the unavailability of enough reliable data." (Hare, 2004). This is a gap that enhanced DSS tools should try to fill in the future in order to allow the practical implementation of the holistic approach required by IWRM.

9. ***Environmental assessment is a capability usually offered to DSS by simulation models.***

- Hydrologic models can support the analysis of the river basin and are integrated in several DSS proposed over the past years. These consist in practice of modelling tools with a dedicated interface in order to be used by policy makers, or at least by non-specialists.
- DSS can help in developing programmes for mitigating the effects of extreme water-related events (floods and draughts) as requested by commitment IV (d) of the WSSD implementation plan (UN, 2002)

10. ***The data issue (i.e. the availability of data for informing the decision process) should be approached at the beginning of the study.***

- DSS should help to collect, stock, elaborate and provide data and knowledge. "**Clear information on the origin and reliability of data improves trust and prevents the eventual controversies"** (Maurel, 2003).
- Data should be available for all relevant domains (hydrological and socio-economic) to be able to exhaustively characterize the problem at hand.
- **DSS tools should be adapted to the availability of data**, but also to cope with unexpected lack of information.

11. ***Simulation models help in the evaluation of the river basin systems' components (hydrological or socio-economic) evolution.***

- The development of future scenarios is, by definition, a simulation exercise; therefore models are usually required components of the DSS.
- **Scenarios** are needed to explore how the future may unfold and thus to design policies and plans that may be adapted to cope with expected changes. The analysis of alternative options in the contexts of divergent possible futures gives strength to the decision.

Policy/Decision Design link3

12. ***Water policies, measures and implementation instruments (economic, regulatory, technical and others) are to be defined outside the DSS.***

- The design of appropriate water allocation policy reforms, balancing water demand and water supply, can benefit from improved modelling of water allocation at the river basin level. Potential users should not expect that DSSs may provide definitive solutions to the design of sustainable water policies.
- **The development and application of DSS should mainly aim at helping the different parties understand the problem at hand.**
- Many tools, designed for dealing with specific and well-defined problems may provide solutions by applying optimisation methods, such as multi-objective analysis, which are adopted to identify best technical solutions (e.g. in case of water allocation). An extensive list of domains for which DSS are developed is reported in box 1.

- Each option should be evaluated in relation to the particular economic, social and environmental features of the region where the model is applied.

13. ***The ability to implement expert knowledge (i.e. detained by qualified persons) in the process is of fundamental importance.***

- Initial users' commitment requires a **clear and comprehensible specification of the system** that includes what the system should provide and how. Therefore it is beneficial for the success of DSS to assure the **support of a sponsor** from within the organisation, who realises the benefits from the DSS and helps to explain them to others.
- DSSs should be framed within methodological frameworks in which all the phases and components of the policy/decision making process are considered.
- As the DSS development process progresses, the cost of changes to system specification are increasingly costly and require more time. It is therefore necessary to **assure system flexibility**.

"The use of modelling in support of clear understanding of IWRM and water systems research requires that all participants and stakeholders have a clear understanding of the strengths and limitations of the models" (Gyawali et al., 2006)

The EUWI–Research Component

14. ***Indicators play a fundamental role in providing concise and targeted quantitative features of the various aspects to be considered in the choice.***

- When the selection of preferred choice is based upon a multi-criteria approach, indicators play the role of quantitative or quasi-quantitative estimations of the performances of the various alternative options for the selected evaluation criteria.

Box 1: Domains in which DSS can support improved water management and governance.

- The primary goal of water management is to meet demand. DSS help in the investigation of existing gaps between water supply and demand and related impacts (i.e. water shortage, economic losses due to climatic changes, water pollution, flooding); link4 link5
- Fostering communication and public participation. link6
- Assessment of present ecological status, impacts and pressures. link7
- Management of transboundary river basins. link8
- Environmental impact assessment (EIA). link9
- Reservoir operation: management of dams and reservoirs operation and forecasting. Identification of the location of concrete structures (water treatment plants; dams; weirs; uptakes; monitoring stations; ...). link10
- Hydropower operations' simulations and forecasting.
- Risk Assessment: flood forecasting, travel-time computations in emergency warning systems in the event of accidental pollution (Early-warning systems). link11 link12
- Floods and drought management under scenarios of climate change. Drought mitigation measures during planning and operation of water systems. link13
- Models are often used for the enforcement of laws (i.e. the Water Framework Directive – WFD): specifically tailored DSS can help with the implementation of water legislation and guide stakeholders to check on the authority's performance and agenda management.
- Assessment of the cost-effectiveness, the social impacts and sustainability of water management measures.
- Integration of multi-criteria methods of evaluation for the different options identified allows their benchmarking and raking
- Optimisations models integrated in the systems help to identify the best between the generated alternatives.

For more information on the domains of DSS application please refer to the "Report on development and implementation of DSS tools in the Mediterranean Area", Nostrum-DSS Deliverable 5.5 (Fedra, 2006) and the Nostrum-DSS Deliverable 2.4, the "Report on multi-sectoral approaches to DSS uses in water management" (Abu-Zeid et al., 2006)

CASE STUDIES	**Examples of development and application of DSS**	**Participatory approaches' examples of application in policy/decision processes**	**Environmental Impact Assessment studies**	**Operational management**
Algeria		X		
Croatia		X	X	
Cyprus			X	
Egypt	X			
Greece		X		
Israel/Palestine		X		
Italy	X	X		
Lebanon		X		
Morocco	X			X
Portugal		X		
Spain	X			
Syria	X			
Tunisia		X		
Turkey		X		X

Table 1. Examples of good practices reported in the Nostrum-DSS case studies extracted from the National Reports.

Policy/Decision Choice

15. ***A plethora of approaches is available for the assessment of alternative options and for integration in modelling components of DSS.***

- Some of the methods facilitating the choice of decision makers on the basis of the elicitation of their preferences and/or of criteria of economic rationality or other disciplinary approaches: **Cost Benefit Analysis (CBA), Multi-criteria Analysis (MCA), Group Decision Making (GDM), Sustainability Analysis, etc.** One critical factor which should be mentioned in this regard is that the result of the choice obviously depends upon the method adopted and there are no clear rules for the identification of the approach to be preferred.

16. ***Sensitivity and uncertainty analysis, quality assurance should be carried out during all the development phases and the outputs associated with the system's results***

- Uncertainty pervades all aspects of environmental policy-making. It poses several practical challenges, in terms of identifying and describing (quantifying, qualifying) uncertainties, propagating them through decisions and communicating the results of an uncertainty analysis.
- The adoption of the DSS should encourage the competent administration to deal with the various sources of uncertainty and to include this information in the communication of results. **Quality assurance techniques** may significantly contribute towards enhancing the credibility of ICT tools developed at the interfaces between science and policy.

17. ***DSS should present the results in such a way that people can understand them.***

- For example there should be on-screen cross-referencing of information i.e. the links between action (input) and effect (output) must be clear (Hare, 2004)

18. ***The improvement of the quality of the decision process is the main indicator of DSS success.***

- In evaluating the results of the process it should be considered that the success in the DSS implementation and application does not depend only upon the adoption of the results.

POLICY BACKGROUND

Introduction

The aim of the design and implementation of a water policy or management plan is stated by the WSSD Plan of Implementation Chapter IV point 24 (c):

> "Improve the efficient use of water resources and promote their allocation among competing uses in a way that gives priority to the satisfaction of basic human needs and balances the requirement of preserving or restoring ecosystems and their functions, in particular in fragile environments, with human domestic, industrial and agriculture needs, including safeguarding drinking water quality" (UN, 2002)
>
> **WSSD Plan of Implementation (Ch IV 24 (c))**

Thus Policy and Decision Makers need to identify and evaluate alternative water management system designs or management plans considering all economic, ecological, environmental, social and political impacts, ensuring efficiency, equity and sustainability. Scientific investigations should support those analyses and the process of actions' implementation in ways that are relevant to policy and management needs. Thus, ***the primary need towards an improved water management approach is to fill the gaps between the different languages, priorities and objectives of researchers, policy makers and stakeholders.***

1. Lack of financial resources is one of the main obstacles towards achieving the goal of reducing by half the proportion of people without access to safe drinking water and basic sanitation by 2015 as stated by the MDGs (DFID, 2006). More money should be invested in water and

> **UN Millennium Development Goal n° 7**
>
> *"Ensure environmental sustainability:*
>
> **Target 9**: Integrate the principles of sustainable development into country policies and programmes; reverse loss of environmental resources;
>
> **Target 10**: reduce by half the proportion of people without sustainable access to safe drinking water by 2015." (UN, 2000)

sanitation and the available resources should be spent effectively and fairly. Strategic coordination, based on country-specific and donor priorities, is necessary for the implementation of concrete interventions to respond to the challenges identified (MED-EUWI, 2005). Moreover **weak**

governance, political instability and lack of capacities at the country level heavily contribute to hindering the implementation of efficient IWRM policies and plans (MED-EUWI, 2005).

2. It is widely documented that **experiences and information are not easily shared between policy makers and scientists**. It is therefore important to improve coordination and exchange of information between different institutions, stakeholders and research organizations. Dissemination and sharing of adequate information and knowledge should be guaranteed.

> "Improve water resource management and scientific understanding of the water cycle through cooperation in joint observation and research, and for this purpose encourage and promote knowledge-sharing and provide capacity-building and the transfer of technology, as mutually agreed, including remote-sensing and satellite technologies, particularly to developing countries and countries with economies in transition." (UN, 2002)
>
> **WSSD Plan of Implementation (Ch. IV 25 (c))**

3. **Advising, training and developing appropriate tools are examples of the** support **that** researchers should provide to policy/decision-makers for the design and implementation of effective and efficient water management plans. **The tools or solutions developed within the academic sphere are often too complex**, **time-consuming or expensive** to be acquired and implemented in practice.

4. Adopting a **holistic approach** to water management means that different components of the natural and human water systems have to be integrated. Generally, the appropriate water management units are the **basin (or catchment) level**. It is at that geographical scale that hydrologic, social and economic relationships can be analysed and integrated. This increases the number of factors managers and policy makers have to consider during the implementation of the water policy/decision process.

Actor and Problem Analysis

*Adopting an IWRM Plan requires **transparency and acceptance of the decision/policy process,** which must be assured through the involvement of the multiple actors. Policy makers cannot rely only on quantitative technical information, nor can they manage complex choices by considering power relationships only. Decision support systems might be of great help as they allow the integration of different types and sources of qualitative and quantitative knowledge and the transparent management of the various actors involved (experts, stakeholders, etc.) (see points 5 to 6)*

*Prior to the development and implementation of water policies or plans a clear **analysis of the problem for a careful identification of objectives and constraints** has to be carried out. It consists in a detailed exploration of the whole system, the hot spots and critical issues able to simplify or hinder the achievement of the management goals, drivers and pressures (see points 7 to 11).*

5. The participatory approach is becoming a prerequisite of every legislation and plan dealing with environmental management. According to GWP **public participation (PP)** requires "that stakeholders at all levels of the social structure have an impact on decisions at different levels of water management" (GWP-TAC, 2000). Only PP at all levels (international, national regional and local) may assure transparency and accountability of the policy/decision process. Ensuring communication and exchange of information and knowledge is one of the decisive success factors for solving a water management problem.

> "Facilitate access to public information and participation, including women, at all levels in support to policy and decision-making related to water resources management and project implementation" (EC, 2003)
>
> **The European Water Initiative: Water for Life**

6. An effective implementation of a management plan requires an adequate involvement of all relevant stakeholders and the **consideration of multiple points of view and values**. Thus, key actors have to be identified **(stakeholder analysis)** and their relations within a social network made explicit **(social network analysis)**. This assures the detection and assessment of possible conflict situations **(conflict assessment)** on which the process should focus, in order to limit the probabilities of conflicts and oppositions. To guarantee an improvement in local water governance, adequate consideration of the gender issue (i.e. the women's role) and of marginalized groups to be involved in the procedure must be considered. Appropriate tools should be adopted to facilitate the communication and elicitation of local knowledge.

7. Towards the design and implementation of effective water policy sound **institutional and legislative frameworks** as well as the availability of financial incentives and **technical facilities** are fundamental, but often weak or missing. The evaluation of the actual management capacity is essential and should be carried out at the beginning of the IWRM process.

8. The different **water uses** (urban i.e. water supply, sanitation services and wastewater management; agricultural i.e. concerning mainly the installation for irrigation; industrial i.e. hydropower, etc.; touristy and environmental) need to be identified and analysed. **Socio-economic analysis** provides the needed theoretical approaches and methods.

9. **Countries need to strengthen their capacities in reporting the state of the water and assessing their own water resources.** Key challenges identified by the Mediterranean component of the European Water Initiative are "water pollution and environmental degradation, overexploitation of the water resources, especially groundwater; non-sustainable management and non-renewable groundwater resources." (MED-EUWI, 2005)

> "For the development of national integrated water resources management a central activity area concerns the "improvement of water resources monitoring and assessment (such as hydrometric/water quality monitoring system, upgrading of environmental laboratories etc) as well as improved reporting capacities to effectively meet international, regional and national reporting requirements/obligations" (MED-EUWI, 2005)
>
> **The Mediterranean Component of the EU Water Initiative (MED EUWI)**

A particular challenge policy makers are facing is the fulfilment of an adequate **environmental assessment**, which includes all actions aiming at the evaluation of the quality and quantity/availability of water resources. Another important task to be carried out regards the evaluation of the risk associated to the occurrence of floods and drought.

10. To evaluate the present system's conditions, a large quantity of data is needed. Often **data are not available** or the origin and reliability of data are difficult to assess. It is required to **improve data collection and data analysis**.

11. **Scenarios** of the main drivers (i.e. climate change and land use) should be identified and constitute the frame in which the impacts of different management options identified will be modelled in the next phase.

Policy/Decision Design

Comprehensive analytical tools are needed to support river basin management combining socio-economic, political, institutional, technological potentials and hydrological constraints. ***Modern DSSs can promote understanding of system dynamics and help in structuring the decision process.***

12. The development of basin-level **water policy** demands the identification and evaluation of a number of alternative management options. Each option derives from the selection of one or more measures that can be technical (i.e. the construction of dams, the adoption of technologies for pollution control, water-saving irrigation techniques) regulatory or economic. The options designed should be consistent with the other national agricultural and economic development strategies and should take into account environmental requirements.

> "Employ the full range of policy instruments, including regulation, monitoring, voluntary measures, market and information-based tools, land-use management and cost-recovery of water services, without cost recovery objectives becoming a barrier to access to safe water to poor people, and adopt an integrated water basin approach." (UN, 2002)
>
> **WSSD Plan of Implementation (Ch. IV 25 (b))**

- Especially in situations of water scarcity, alternative policy options need to be designed to make a **more rational economic use of water resources**. The primary objective of water management is to **meet demand**: (i) bridging the gap between demand originated from different uses and the supply originated from different sources; (ii) assessing allocation efficiency and sustainability; (iii) assuring reliability of supply. Inter-sectoral allocation of water between competing users is a major issue, common to the whole Mediterranean (e.g. competition between tourists and residents, or between agriculture and the other sectors).
- Usually water management strategies and plans are developed to **respond to the enforcement of laws** (i.e. in Europe the Water Framework Directive). This is a sector of interest and great potential for DSS tools that, if adequately adapted to the specific requirements and time/spatial scales, may significantly help policy/decision makers to respond to evolving regulatory obligations.

> "Integrated water resources management also provides a framework to promote peace and security in transboundary water basins." (EUWI, 2005)
>
> **The European Water Initiative: Water for Life.**

- Frequently measures have to be taken at the **transboundary level.** In a broad sense transboundary does not necessarily mean the involvement of two or more countries, but also of various administrations with competences in different areas of the same watershed. In all cases the complexity of developing plans and policies necessarily increases (e.g. by providing compensatory measures between upstream and downstream communities). Countries and competent authorities have to be supported in developing adequate administrative and operational mechanisms for the management of shared water bodies (MED-EUWI, 2005)

13. A key challenge in the water sector in the Mediterranean is the lack of skilled and motivated water professionals (MED-EUWI, 2005).Given the complexity of the problems at hand and their specificity to local situations, **expert knowledge** may provide fundamental support. In that case adequate techniques are needed for scientifically robust expert elicitation and integration in the decision process. To **explore the management/planning system and build a shared vision of the problem**, numerous techniques and tools are available (Cognitive Mapping, Participatory Modelling, Conceptual Frameworks, Models and Simulations).

14. An appropriate selection of **Indicators** is functional to the evaluation of the designed alternative options.

Policy/Decision Choice

Many capital investments can result in irreversible economic and ecological impacts. *The use of models is not going to eliminate the possibility of making mistakes. However, a combination of simulation models and a DSS tool can better inform policy/decision makers and other stakeholders in assessing future consequences, the benefits and costs, and a multitude of other impacts associated with alternative plans or management policies (Loucks et al., 2005). Models can help identify the tradeoffs among conflicting measures of system performance.*

15. The **assessment and evaluation of impacts** (on agricultural production, industrial and household water use, environmental sustainability and water quality) originated from the various water management/policy options identified is the primary goal of this phase. Choosing between different alternative water policies or management options, demands the definition and evaluation of their **feasibility and the economic benefits and costs related to their implementation.** Other criteria to be included are the extent to which any decision meets **environmental, ecological** (see target 24 (d) of the WSSD plan of implementation) **and social targets**.

> "Intensify water pollution prevention to reduce health hazards and protect ecosystems by introducing technologies for affordable sanitation and industrial and domestic wastewater treatment, by mitigating the effects of groundwater contamination, and by establishing, at the national level, monitoring systems and effective legal frameworks." (UN, 2002)
>
> **WSSD Plan of Implementation (Ch. IV 24 (d))**

16. Improved documentation of the issues for the justification of decisions to be taken or already made is needed to guarantee transparency and effectiveness of the decision process **(quality assurance**, **uncertainty and sensitivity analysis)**.

17. A clear presentation of the results of the policy/decision analysis helps to legitimate the decision process, leading to a better understanding of the problem by all stakeholders.

18. The adoption of the policy/plan should to be monitored to evaluate the choice made and to gain insights for future revisions or progress.

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ANNEXES

ANNEX 1. Links and further readings

Introduction

Various attempts have been made with the aim of facilitating the dissemination of tools (see for instance the WISE-RTD portal at (http://www.wise-rtd.info/) but also of the methodological frameworks: the NetSyMoD portal is an example (http://www.netsymod.eu/).

For further information on the set up, management and use of effective and efficient networks please refer to the GTZ guide “Work the Net. A management Guide for Formals Networks” (Egger, 2006) http://www.cap-net.org/FileSave/38_Work_the_Net.pdf

***Existing networks*:**

- IW:LEARN (The GEF International Waters Learning Exchange and Resource Network) http://www.iwlearn.net/
- Gender and Water Alliance http://www.genderandwater.org/
- Arab Integrated Water Resources Management Network (AWARENET) http://www.cap-net.org/ShowNetworkDetail.php?NetworkID=3
- Euro Mediterranean Information System (EMWIS/SEMIDE): aims at facilitate and improve access on information between the Euro Mediterranean partnership countries http://www.emwis.org/
- Transboundary Water Information Exchange Network for the South Eastern Europe (TWIEN SEE) http://www.watersee.net/

Manuals for the implementation of IWRM plans:

- “Integrated Water Resources Management” (GWP-TAC, 2000) http://www.gwpforum.org/gwp/library/TACNO4.PDF
- The Global Water Partnership (GWP) manual on IWRM on “Catalyzing change” (GWP-TAC, 2004)

EN: http://www.gwpforum.org/gwp/library/Handbook.pdf

FR: http://www.gwpforum.org/gwp/library/Catalyzing_change_French.pdf

- “Integrated Water Resources Management Plans. Training Manual and Operational Guide” (Taylor et al., 2005); http://www.cap-net.org/TMUploadedFiles/FileFor67/IWRMplansENGLISH.doc

Others related publications:

- “Concepts in integrated Water resources management” related to the Western Asian Countries (ESCWA(a), 2005) http://www.cap-net.org/TMUploadedFiles/FileFor154/Module_1_Introduction.pdf
- “Water Supply, Sanitation and Health Within IWRM Consideration” http://www.cap-net.org/TMUploadedFiles/FileFor154/Module_6-__Water_supply_Sanitation_and_health.pdf

“Economic dimension of IWRM” (ESCWA(d), 2005) http://www.cap-net.org/TMUploadedFiles/FileFor154/Module_5_Economic_Dimensions_of_IWRM.pdf

5.

- The « Guidance Document n° 8 on Public Participation » of the European Commission, Common Implementation Strategy for the Water Framework Directive (2000/60/EC) (EC, 2003) http://www.wrrl-info.de/docs/Guidance_doc_8_Public_participa_klein.pdf
- The Advisor’s Guidance Document “Integrated Deliberative Decision Processes, for water resource planning and evaluation” (Kallis et al., 2004) http://ecoman.dcea.fct.unl.pt/projects/advisor/iddp/publications/ADVISOR%20GUIDELINES.pdf
- The HarmoniCA Guidance on “Model-supported Participatory Planning for Integrated River Basin Management” (Becker, 2005) pg. 22-27 http://www.harmoni-ca.info/
- HarmoniCop Manual on “Social Learning in River Basin Management” (Craps(ed.), 2003) http://www.harmonicop.info/_files/_down/SocialLearning.pdf
- The Harmonicop HandBook “Learning Together to manage Together. Improving Participation for Water Management” (Ridder et al., 2005) http://www.harmonicop.info/HarmoniCOPHandbook.pdf
- “Public Participation and the European Water Framework Directive. Role of Information and Communication tools” (Maurel, 2003) http://www.harmonicop.info/_files/_down/ICTools.pdf
- “Water management: Guidance on public participation and compliance with agreements” (UNECE-WGWM, 2000) http://www.unece.org/env/water/publications/documents/guidance.pdf

6.

- The « Guidance Document n° 8 on Public Participation » of the European Commission, Common Implementation Strategy for the Water Framework Directive (2000/60/EC) (EC, 2003) **pg. 63-68** http://www.wrrl-info.de/docs/Guidance_doc_8_Public_participa_klein.pdf
- “Conflict and Cooperation in the Management of International Freshwater Resources: a Global Review” (UNESCO) (Mostert, 2003) http://unesdoc.unesco.org/images/0013/001333/133305e.pdf
- The book Chapter of IRDC/World Bank “Stakeholder analysis and conflict management” (Ramírez, 1999) http://www.idrc.ca/en/ev-27971-201-1-DO_TOPIC.html

“Stakeholders and conflict resolution in IWRM” (ESCWA(c), 2005) http://www.cap-net.org/TMUploadedFiles/FileFor154/Module_4_-Stakeholders_and_conflict_resolution_in_IWRM.pdf

7.

- The “Building High-Performance Water Management Institutions” (IWMI, 2003) (http://www.iwmi.cgiar.org/waterpolicybriefing/files/wpb05.pdf) and “Institutions for International Freshwater Management” (Burchi et al., 2003) (http://unesdoc.unesco.org/images/0013/001324/132478e.pdf)
- The document addresses the required legislative and organizational frameworks for an effective governance and implementation of IWRM policies in the Arab region. It also discusses current water legislation and institutional frameworks and their required reforms. (ESCWA(b), 2005) http://www.cap-net.org/TMUploadedFiles/FileFor154/Module_3_Legislative_and_organizational_frameworks.pdf

8.

- The « Guidance Document n° 11 on Economics and the Environment » of the European Commission, Common Implementation Strategy for the Water Framework Directive (2000/60/EC) (EC, 2003) http://forum.europa.eu.int/Public/irc/env/wfd/library?l=/framework_directive/guidance_documents/guidancesnos1seconomicss/_EN_1.0_&a=d

  And the Policy Summary: http://forum.europa.eu.int/Public/irc/env/wfd/library?l=/framework_directive/guidance_documents/gds01swatecospolicyssumm/_EN_1.0_&a=d

9.

- RIZA “Guidelines on Monitoring and Assessment of Transboundary Rivers” (UNECE, water series No3) (2000) http://www.unece.org/env/water/publications/documents/guidelinestransrivers2000.pdf
- “Water Pollution Control - A Guide to the Use of Water Quality Management Principles” WPC http://www.who.int/water_sanitation_health/resourcesquality/watpolcontrol.pdf

10.

- The Transcat project deliverable “Standard Procedure for Data Acquisition” (Bender et al., 2004) (http://www.transcat-project.net/Deliverables/WP4/dl4-1%20pt2_comp.pdf) contains common standard to be used for data acquisition and to evaluate existing data in terms of quality and comparability.

16.

- RIVM/MNP “Guidance for Uncertainty Assessment and Communication: Tool Catalogue for Uncertainty Assessment” (J. P. van der Sluijs, 2004; J.P. van der Sluijs, 2004)

- HarmoniCA Guidance on Uncertainty Analysis can provide practical materials for further information (Refsgaard et al., 2005)

ANNEX 2. Examples of existing DSS for different domains related to water resource management.

Integrated Water Management

DSS for Sustainable ECOsystem MANagement in Atlantic Rain Forest Rural Areas-ECOMAN EU project-http://www.uatla.pt/ecoman/wp8.htm

EcoVision (Decision Support System for the development and evaluation of visions for ecosystems in valleys) developed by RIKS http://www.riks.nl/Projects/EcoVisie

GIBSI (Integrated modelling software for watershed management-GIS based)-http://www.inrs-ete.uquebec.ca/activites/modeles/gibsi/francais/accueilgibsi.htm

INFRAPLAN (strategic planning of water supply infrastructures through development of a spatially discretised strategic water demand and supply analysis tool) -TiGrESS (Time-Geographic approaches to Emerging and Sustainable Societies) EU project. http://ec.europa.eu/research/environment/newsanddoc/article_2697_en.htm#2

IRAS (Interactive River and Aquifer Simulation- to evaluate the performance or impacts of alternative designs and operating policies of regional water resource systems)

MADWICA DSS-EUREKA E! 2721 EU programme-http://www.eureka.be/inaction/viewSuccessStory.do?docid=1765007

mDSS (Multi-sectoral Integrated and Operational decision support system for sustainable use of water resources at the catchment scale) - MULINO EU project - http://www.netsymod.eu/mdss/

MedAction DSS-MedAction (Policies for land use to combat desertification) EU project-http://www.icis.unimaas.nl/medaction/

MIKE BASIN (water allocation, conjunctive use, reservoir operation, or water quality issues) http://www.dhigroup.com/Software/WaterResources/MIKEBASIN/Details/Introduction.aspx

OPTIMA DSS (Optimisation for Sustainable Water Management) - OPTMA EU project http://www.ess.co.at/OPTIMA/

RAMCO- (Decision Support System for the Integrated Assessment of Sustainable Coastal Zone Management problems) RIKS. http://www.netcoast.nl/projects/netcoast/tools/rikz/RamCo.htm

Real-life scale integrated catchment models for supporting water- and environmental management decisions-The Tisza River (EU) - http://www.tiszariver.com/index.php?s=results

WFD-explorer –Delft-Hydraulics - http://www.wldelft.nl/cons/area/wqe/krw/explorer.html

WMSS (Water Managemnet Support System) Integrated and problem oriented water management system at catchment scale for coastal water resources. -MEDITATE EU project-http://www.meditate.hacettepe.edu.tr/prjdesc/objectives.htm

WSM DSS-WaterStrategyMan EU project - http://www.geomin.unibo.it/hydro/WSM/DSS_demo.htm

Urban Water Management

ADSS (Adaptive Decision Support System for the integration of stormwater source control into sustainable urban water management strategies)-DayWater (EU)-http://www.daywater.cz/

Decision Support Tools for Sustainable Water Network Management-CARE-W EU project-http://care-w.unife.it/intro.html

DSS for rehabilitation of Sewer Networks-CARE-S EU project-http://care-s.unife.it/index.html

MIKE NET (Water distribution systems including real-time control and water quality - based on the US-EPA EPANET engine) DHI-Software http://www.dhigroup.com/Software/Urban.aspx

MIKE STORM –(Stormwater modelling) DHI-Software http://www.dhigroup.com/Software/Urban.aspx

MIKE SWMM - Wastewater and stormwater modelling based on the US-EPA SWMM engine- Freeware DHI-Software http://www.dhigroup.com/Software/Urban.aspx

Modelling tools for planning of alternative approaches for sustainable urban water systems AISUWRS (EU project)- http://www.urbanwater.de/.?id=1&si=MTE1MDcxNDY5NC41MzU2fDE1Ny4xMzguMS4zNHwg

Deliberation Support Tools

TIDDD (Tools to Inform Debates, Dialogues & Deliberations) and DTS (Discussion Support Tools) - GOUVERNe EU project -http://gouverne.c3ed.uvsq.fr/index.html

MERIT DSS http://www.merit-eu.net/

Water quality management

BASINS (Better assessment science integrating point and non-point sources) http://www.epa.gov/OST/BASINS/

BAYES NET-Neuse River, Estuary Modeling and Monitoring (ModMon) - http://es.epa.gov/ncer/fellow/progress/99/borsukma00.html

CATCHMODS (Catchment scale management of diffuse sources model)-Australia http://icam.anu.edu.au/html/catchmods.html

DANUBIA-(an integrated environmental decision support system) GLOWA-Danube-project http://www.glowa-danube.de/

Decision Support System for the Effective Management of Freshwaters under condition of climate change-EURO-Limpacs-http://www.eurolimpacs.ucl.ac.uk/publicarea/workprog.php#wp9

DESERT- (DEcision Support system for Evaluation of River basin) International Institute for Applied Systems Analysis IIASAsTrategies http://www.iiasa.ac.at/Research/WAT/docs/desert.html

Elbe-dss (DSS for river water quality management)-Elbe-DSS project- http://elise.bafg.de/servlet/is/3283/

GREAT-ER (Geography-referenced Regional Exposure Assessment tool for European Rivers)- http://www.great-er.org/files/great-er_web_manual.pdf

IQQM (Integrated Quantity and Quality Model)-Australia- http://www.mssanz.org.au/modsim05/papers/hameed.pdf

MOIRA DSS (A model-based computerised system for management support to identify optimal remedial strategies for restoring radionuclide contaminated aquatic ecosystems and drainage areas)-MOIRA (EU)-http://user.tninet.se/~fde729o/MOIRA/Software.htm

Management of transboundary basins

Transcat-DSS (DSS for optimal water management of transboundary catchments, in context of the implementation of the EU Water Framework Directive.)-TRANSCAT (EU)- http://transcat.vsb.cz/new/php/results/index.php?lang=en

Environmental Impact Assessment

EIADSS (Environmental Impact Assessment Decision Support System for the evaluation/prediction of irrigation project)

http://www.cedare.int/index/software/dss2.htm

WATERWARE (Water resources management information system)- EUREKA project EU487 and related project -http://www.ess.co.at/WATERWARE/

Operational Management

AQUATOOL - a generalized decision-support system for water-resources planning and operational management (Andreu et al., 1996) http://www.upv.es/aquatool/

Drought mitigation

DSS for the management of integrated water resources systems focused to drought prevention and mitigation -WAM-ME-http://www.dica.unict.it/users/fvaglias/Wam-meWeb/index.htm

DSS-DROUGHT (Decision support system for mitigation of drought impacts in the Mediterranean regions) DSS-DROUGHTcEU project-http://cordis.europa.eu/search/index.cfm?fuseaction=proj.simpledocument&PJ_RCN=2727822&CFID=9657340&CFTOKEN=48006336

http://www.emwis.net/initiatives/fol060732/proj144348

Early Warning Systems

DELFT-FEWS (Flood early warning system)-Delft-Hydraulics-http://www.wldelft.nl/soft/ribasim/int/index.html

FLOODRELIEF-DSS- (real-time decision support system integrating hydrological, meteorological and radar technologies) FLOODRELIEF EU project-http://projects.dhi.dk/floodrelief/index2.asp?goto=http%3A//projects.dhi.dk/floodrelief/overview.htm

FLOODWORKS (generic and modular software for real-time flood forecasting & warning) http://www.wallingfordsoftware.com/it/products/floodworks/

MIKE FLOOD Watch – (Decision support system for real-time flow forecasting) DHIsoftware http://www.dhisoftware.com/general/Wateres_Overview.htm

Risk Assessment and Management

ANFAS (DSS for Flood Prevention and Protection) - ANFAS EU Project

DECIS (Integrated risk index and a decision support system for prioritisation of risks and mitigation measures)-MODELKEY EU project -http://www.modelkey.org/

DSS for the assessment of flood risk-EUROTAS EU project-http://www.hrwallingford.co.uk/projects/EUROTAS/

http://www.ercim.org/ANFAS/poster-anfas.pdf

RAMFLOOD DSS (DSS for Risk Assessment and Management of Floods) –RAMFLOOD EU project-http://www.cimne.upc.es/ramflood/telework/

ANNEX 3. <u>The Nostrum-DSS case studies extracted from the National Reports</u>

ALGERIA	
Setting	The “Great Sebkha of Oran”, is a RAMSAR salt lake basin located south of Oran within the whole Oranie Chott Chergui Hydrographic Basin. The Sebkha is alimented by an hydrographic network from the north (Murdjadjo) and the south (Tessala).
Actor and Problem Analysis	This global system (lake and catchment) is the heart of a problem linking between **local development and ecological preservation**. While the plains have a **great agricultural potential,** north and south of the Sebkha have experienced **opposite types of development**. The northern part beneficiated from the extension and the development of Oran and its **industrial activity** which is now a source of major pollution (urban and industrial wastes which leads to a greater salinization of the Sebkha). The southern part remained unexploited in terms of infrastructures. The water resources (both surface and underground waters) of the Great Sebkha **are not known** with accuracy.
Policy/Decision Design	In 2002, the **Ministry of Water Resources** (MRE) entrusted a French engineering private institution to undertake a **global study leading to an adequate solution** for the Sebkha problem. The process was initiated through a **participative approach**, including different actors (decision-makers, local representatives, municipalities, civil society, industrials, agriculture, universities, etc..).
Policy/Decision Choice	NA
Shortcomings	The MRE played the major role in the participative approach while the **other actors often had a marginal position** (local communities, specialized agencies, scientists, NGOs..).

CROATIA	
Setting	Cetina is a typical karstic water course with its watershed and riverbed formed in the area surrounding the deep Dinara karst. The length of the Cetina River, from its source (382 m height) to its estuary extends to 105 km. The Cetina riverbed is highly fragmented by many reservoirs and hydro power plants. For this reason, the Cetina watershed has been frequently considered as two independent parts: the first one is upstream of the Prančevići dam while the second one is downstream.
Actor and Problem Analysis	The economic structure of the continental part of the watershed (i.e. the Herzeg-Bosnian and Croatian part) differs significantly from that of the coastal area. In the upper part of the watershed, the dominant economic activities have been those relating to **industry, mining, electrical supply, trade, catering and agricultural production**; the share of other economic sectors has been marginal. In the **coastal area**, the dominant economic activities have **constituted industry, trade and tourism**. The problems of the area arise from the competitive use of waters between these actors; they can be summarised as follows: Hydro-energy production, domestic water supply, irrigation, flood protection and domestic and industrial wastewaters.

	This lead to **series of protests** from primary stakeholders, greens and water users who observed negative effects on environment and drinking water quality that resulted from the change in the Cetina water regime downstream from the Prančevići dam.
Policy/Decision Design	State institutions therefore undertook steps to solve the problem and organise **meetings where official bodies and stakeholders** took part: it was decided to analyze the problem and solve it in accordance with the law. Corresponding **ecological research** and **EIA study** were ordered to determine the minimal ecologically acceptable flow of the river as well as economical flow in accordance with downstream water uses.
Policy/Decision Choice	The problems have been solved only for **one of the river sections** where conflict of interests was most pronounced. In the future **deeper conflict of interests** is expected because of expected privatization of the HPP and intensification of conflicts between public and private interests. Conflicts are also expected due to the fact that the river watershed belongs today to two States, Croatia and BIH, with different interests. It is today a **transboundary** water resources problem. As an **Integrated Water Resources Management Master Plan** of the River Cetina has not been developed yet, satisfactory basis and DSS for problem solution still do not exist.
Shortcomings	**Environmental Impact Assessment Studies** have been developed along with the Impact on Downstream Users Studies, **public debates, agreements and discussions** have taken place and new operating regime of the HPP on the critical section of the river has been accepted. Minimum river flow is increased in the critical period of the year, therefore the eco system and downstream users are protected, and other solutions have been agreed, reducing the harmful effects on the river ecosystem and enabling the use of the river for other purposes, specially for safer water supply. Water supply safety and quality of water used for water supply have been increased.

CYPRUS	
Setting	The Tamassos area is located ina zone of great archaeological significance in the central vicinity of Cyprus, approximately 21 kilometeres south-west of the capital city of Nicosia.
Actor and Problem Analysis	To tackle the depletion of the **deep water** aquifer in the area, to increase the **quantity of drinking water** available and to alleviate the **occasional flooding** that occurs in the Tamassos area the **Community Boards of villages** (Pera Orinis, Pano Deftera, Kato Deftera, Episkopio, Politiko, Anayia, Ergates, and Psimolophou) of the region decided to **build a Dam**. In fact, this initiative/appeal to the relevant authorities originated in the 1940s: the **Water Development Department** (WDD).
Policy/Decision Design	The Water Development Department (WDD) agreed to undertake a **Technical Feasibility Study**, so as to determine whether the Dam is necessary, and-if it is indeed needed- what type of dam it should be. The decision-making followed an **interactive process**, where every effort was made to arrive at an outcome satisfactory to all **stakeholders**: they were **formally involved** and gave their contribution in all the phases of the analysis.
Policy/Decision Choice	The **WDD determined** that the dam should be of the "enrichment" type, and its sole purpose would be the collection of rainwater for the enrichment of the deep water aquifer. The **farmers can however draw water** from the Dam on an occasional basis (in Pera Orinis continuous abstraction is allowed to compensate for the destruction of a chain of wells), once sufficient quantities of rainwater had been collected for the enrichment of the deep water aquifer.

EGYPT	
Setting	With the increase of Egyptian population and almost all of it living in 4% of the country along the Nile shores, the government realized the necessity of accelerating its **horizontal expansion plans into the deserted** and uninhabited regions of Egypt. As part of this horizontal expansion plan, the agricultural land is forecasted to spread out by an area of 3.4 million feddans in several regions of Egypt, by year 2017. The Southern Egypt Development Project (Toshka Project) represents 0.54 million feddans of the total planned agricultural expansion.
Actor and Problem Analysis	- The **problem** concern whether or not to undertake the Southern Egypt Development Project (Toshka Project). The decision is based on an **Environmental Impact Assessment** of which has to be prepared according to the guidelines of the Egyptian Environmental Affairs Agency (EEAA). - The **actors** involved are the following: Archaeologist and Egyptologist Groups ; NGOs; Labour community; Mass media; Parliamentarians; Farmers (Youth); Environmentalists ; Academic Society; Investors; MoT: Ministry of Tourism; MoIFT: Ministry of Investment & Foreign Trade; MoH: Ministry of Health; MoSEA: Ministry of State for Environmental Affairs; MWRI: Ministry of Water Resources & Irrigation; MALR: Ministry of Agriculture and Land Reclamation;
Policy/Decision Design	The impacts of the proposed project and the possible alternatives are determined using the **Environmental Impact Assessment Decision Support System** (EIADSS) for irrigation projects, developed by Centre for Environment & Development for Arab Region & Europe (CEDARE). CEDARE-EIADSS is a computerized checklist supported by an Expert System that evaluates all potential environmental impacts of irrigation projects. The Expert System is based on a set of multiple-choice questions that describes the project impacts on selected criteria. The main objective of using the EIADSS is to **assist the decision-maker in comparing between project alternatives including the no-project alternative**, and identifying the positive and negative impacts. Based on the systematic approach of the EIADSS evaluation, the expected project performance is assessed including the implementation of mitigation measures that may alleviate possible negative impacts.
Policy/Decision Choice	The EIADSS recommended to implement Alternative 1 of the Toshka project, mainly due to its **positive impacts on socio-economics, and on the overall economical well fare of the country**. Overall, the some incidental benefits to the management of the natural resources, and biological life will exceed any possible negative impacts, especially with the implementation of the mitigation measures. Meanwhile, the overall political impact of the project Alternative 1 is positive.

GREECE	
Setting	The **island of Paros** is one of the islands of the Cycladic complex in the Aegean Sea, with an area of 196 km2 and a population of 12,800 permanent residents.
Actor and Problem Analysis	- The main water stress issue is the **peak in demand during the summer months**, due to the high tourist influx onto the island. The existing infrastructure capacity is stretched during that period and is often insufficient to cover demand at peak times, leading to **temporary shortages** that in return are damaging to **tourism.** - The **actors** concerned and to be involved are: Municipality of Paros, Municipal Office of Water Supply and Sewerage of Paros (DEYAP is the administrator of the island's water resources and has an overall responsibility for the type of activities or measures considered and proposed); the Union of Agricultural Associations representing the traditional agricultural character of the island, Union of Room Owners , representing a significant amount of the population, as well as the main activity and the main source of income for the island
Policy/Decision Design	A variety of **data and estimations** (water supply provision and fluctuation; consumption fluctuation; permanent population; tourist arrivals, departures and overnight stays; seasonal population; number of hotels, rooms and beds; occupancy; overnight stays; number of hotels, rooms and beds; occupancy; overnight stays) have been **collected**. Two main categories of stakeholder groups were identified: the first category included stakeholders involved in the promotion of the system and the second included those who would benefit from it. Both categories, however, interacted within the framework of the system. A **series of consultation and awareness meetings** with the selected stakeholders, in the form of personal interviews and focus groups were also organised: opinions, wishes and expectations were discussed during these meetings. The **available data were also reviewed** during these meetings, as stakeholders can be excellent sources of data on their field of interest.The stakeholders proposed **several alternatives** to water resources management that were used during the strategy formulation: three scenarios based on stakeholders' opinions, wishes or expectations lastly emerged.
Policy/Decision Choice	The Strategy developed resulted from the synthesis of the **current responses** regarding water management, the responses proposed by the **stakeholders** and the requirements of the **Water Framework Directive** that can be implemented in this specific area. This Strategy was then evaluated through a series of **indices and indicators** describing the actual range of the activities applicable to the island. The **best available solution** was selected taking into account the results of application of public participation.

ISRAEL/PALESTINE	
Setting	The Dead Sea is the terminal lake of the Jordan Rift Valley. Its surface is currently about 417 m below sea level, which makes it the lowest point on earth; its watershed is shared by Israel, Jordan and Palestine.
Actor and Problem Analysis	The most visible and most disturbing degradation is the **decline of the Dead Sea water level and volume**. Since around 1930 the water level of the Dead Sea has fallen by about 25 m, about half of this alone in the last 20 years: in the past few years the rate of decline was 80-100 cm per year. The basin plays a major role for regional economic activities: **agriculture, industrial** (mineral extraction and water bottling) and **tourism**. For the next few years, plans are for further tourism and industrial development of the area including the construction of over 50,000 new hotel rooms.
Policy/Decision	As part of the part of the Dead Sea Project research work, **Focus Group**

Design	**Meetings were organised.** They involved the Ministry of Agriculture, Ministry of Planning, Environmental Quality Authority, Palestinian Water Authority, Negotiations Affair Department, Palestinian Hydrology Group, House of Water & Environment , Institute of Water Studies – Birzeit University , Palestinian Agricultural Relief Committees and the Applied Research Institute – Jerusalem (ARIJ). The parties **discussed the different plausible alternatives** for solving the environmental and economical problems focusing on the provision of "new water from outside", including rainwater harvesting and wastewater treatment and reuse and the Red-Dead Canal ptoject
Policy/Decision Choice	NA The canal between the Red Sea and the Dead Sea ("Red-Dead Canal") is a 240 km conduit expected to replenish the missing inflow, use the gravity pressure for desalination through reverse osmosis, and for production of electricity. Costs are estimated to be around 3 billion dollars (Pearce 1995). Among the questions that remain unclear are the environmental impacts of the canal, e.g. the chemical changes of the water.

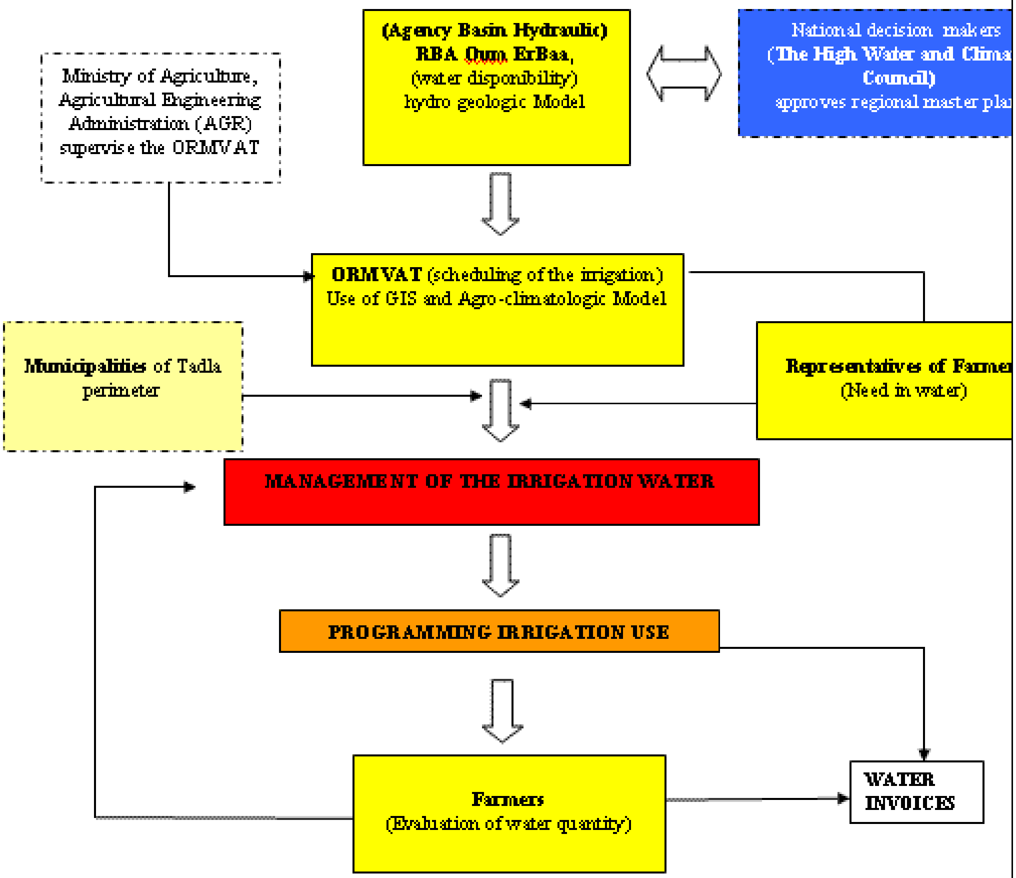
ITALY	
Setting	The Consorzio per la Bonifica della Capitanata , located in the Northern part of Apulia region have to ensure a sustainable development of the region through constant hydraulic regulation works, the supply of water for agriculture and the management of the distribution water network
Actor and Problem Analysis	The available **water is not sufficient** to meet crop water demand, the Consortium has been obliged to act in different directions to save water and promote a more efficient and sustainable use of water resources. This action has been particularly significant since the beginning of the eighties when the price of water has started to increase and water saving practices have become increasingly popular in compliance with the Regional Law 54/80. The **actors** identified for the area are the Capitanata Case Study are the Capitanata Land Reclamation Consortium (it may be considered both a decision-maker and a key stakeholder), the farmers; Aquedotto Pugliese, local communities (they may be considered as primary stakeholders because they are affected either positively or negatively by policy-makers' decisions); archaeologists and environmentalists (they may be considered both as primary stakeholders since they are affected by the decision and as secondary stakeholders since they can contribute to decision-making).
Policy/Decision Design	The activities initially involved for **water saving** the creation of **information and communication tools,** and **structural interventions** on the water distribution network and the introduction of a new generation of flow-meters: Such as technical data sheets on crop water requirements and irrigation scheduling, the publication of weekly bulletins on agro-meteorological data which were distributed to the farmers at the meetings organized at the municipalities, at trade union offices and at the extension service offices of the Consortium. Recently, the Consortium has created and operated its web site (www.consorzio.fg.it), i.e. a set of free services addressed to farmers and aimed at a more efficient water use in the irrigation sector. These services include real-time data and historical records of water availability in the four reservoirs that provide water to irrigated fields and are managed by Consortia; real-time and historical data of weather parameters over the whole area; real-

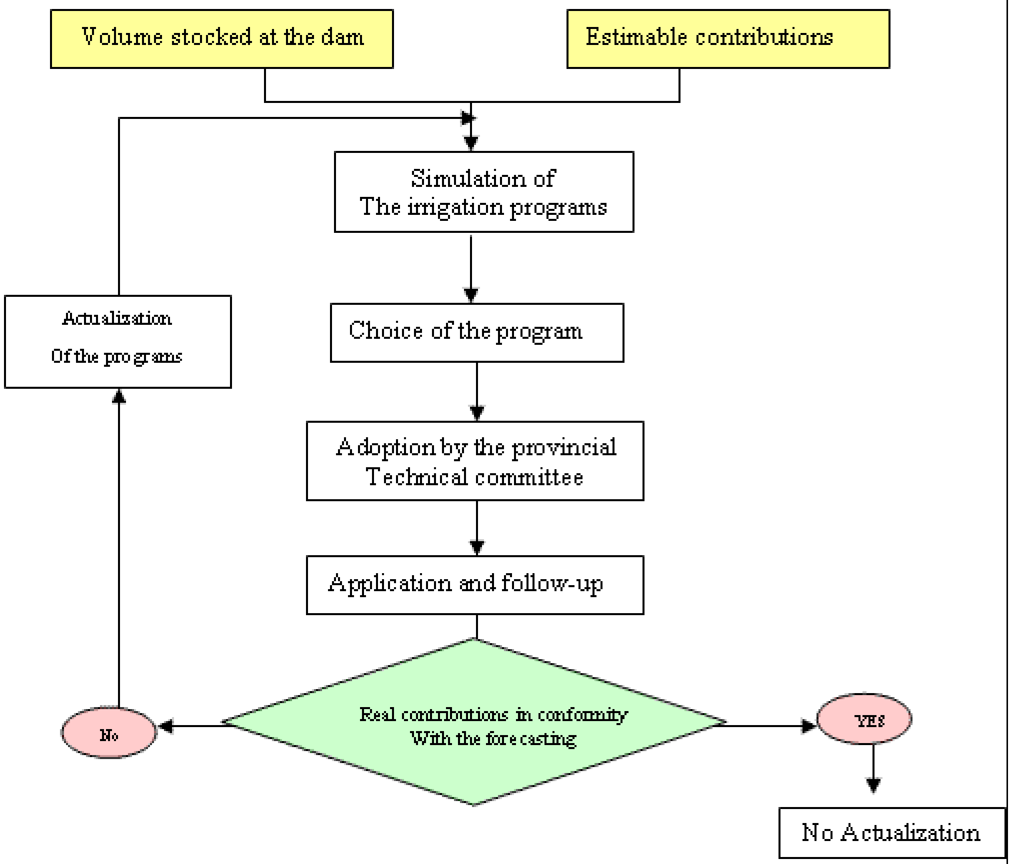
	time irrigation scheduling for the whole area managed by Consortia ; agro-meteorological and phyto-sanitary bulletin.
Policy/Decision Choice	At the beginning of the irrigation season, the volume of water stored in the reservoirs is divided by the supplied acreage and the resulting amount per hectare constitutes the “water duty” available to each farmer. During the irrigation season, according to the quantity of water actually stored in the reservoirs, the technical service can suggest an increase of the water duty per hectare. The network is designed for an **“on-demand” delivery schedule, ruled by tariffs** but during the peak season it often works following a “rotational” delivery schedule. This scheduling is defined by the Administrational Deputation upon the technical service’s advice taking into account different crops’ growth stages and water requirements.

LEBANON	
Setting	The Damour Village relies on both groundwater (public and private wells) and surface water (Damour River) which is **shared** among several villages.
Actor and Problem Analysis	The problems of the area include the **absence of a legislative framework** that ensures the fair water distribution among its users, the **deteriorated quality** of the due to the discharge of wastes (sewage and industrial wastes), the **absence of piped water networks** in the Saadiyat area which leads to the extensive use of **private wells** threatening the availability of the groundwater resources, in terms of quality and quantity. Furthermore, the water resources (public wells) in Damour are used by the Beirut Water Authority for **external supply** in west Beirut. Lastly, the **water losses** through the network were estimated to range between 25 and 50% during the winter season and 45 and 61% during summer. The main actors of the area can be defined as the **ministries** (involved in the development of policies for the proper management of the water resources and implementation of the policies), the **Water and Wastewater Establishments**, the **international organizations and private companies**, the **municipalities** and the **water users**.
Policy/Decision Design	A **participatory approach** has been implemented during the DMP; it involved various stakeholders: a) representatives of the government (MEW, MOE, MOA, MOPH, MOPWT, CDR, LRA, BWA, BIWA, CNRS, and CAS), b) the pilot municipalities, c) water users (community based organizations and the industrial sector in the area), d) experts in the water sector, such as academicians, specialists of international organizations (UNESCWA), non-governmental organizations (NGOs), and e) the media, was followed to set the recommendations for the proper management of the water resources in the area. The stakeholders **proposed elements** for conflict resolution including **coordination and negotiation** between the municipality and the water authority to control over exploitation of the groundwater resources, installation of **metering systems** to control the utilization of water and to monitor the water losses and establishment of the **Damour River Basin committee**. This Would be responsible for: • Conducting a water allocation study to ensure the fair river water distribution among its upstream and downstream users (DSS). • Establishing cooperation mechanisms between the different water users

	• Monitoring the water quantities provided to the agricultural sector (by installing metering systems at the irrigation channels) • Monitoring the quality of the river water • Monitoring and controlling environmental offenses along the river • Promoting awareness and capacity building.
Policy/Decision Choice	NA

MOROCCO	
Setting	The irrigated perimeter of Tadla is one of the oldest of Morocco. The region saw important investments concerning hydraulic infrastructures in 1997, with the construction of the complex of dams Dchar El Wadi-Aït Messaoud. Part of the Oum Er Rbia basin and it is administrated by the irrigation agency of Tadla (ORMVAT) and by the Oum Er Rbia River Basin Agency. The ORMVAT has developed a plan for utilizing surface water in terms of infrastructure development, crop prioritisation, water delivery, public and farmer participation, human resource development and capacity building, and enlargement of irrigated lands. The ORMVAT is continuing on the on-going expansion of modern irrigation in order to improve both water and land productivity.
Actor and Problem Analysis	Water **quantity and water quality degradation** are expected to seriously worsen in in the near future because of the **diversity of users** from the public and private sectors, their **conflicting interests**, including **growing water demands** for the agriculture, the **limited technical and financial capacity** of public entities and private operators, particularly poor farmers. Stakeholders in Tadla plain are separately monitoring water quantity and water quality parameters of interest to them while coordinating little with others. Existing information is scattered. There are no unified databases, and there are no mechanisms for sharing information among users. This results in low efficiency and duplicated efforts. Coordination in collecting, analysing, and sharing information will benefit integrated water resources management in river basin. Use of DSS will allow partners to develop efficient mechanisms for information sharing and design new strategies for water resources management Over time, the three main interacting objectives of ORMVAT Decision makers for developing the irrigation and hence contribute to other water uses are: 1. **Improving hydraulic efficiency** of irrigation systems, 2. Increasing **productivity** and 3. strengthening the **managerial** capacities of the ORMVAT.

Policy/Decision Design	
Policy/Decision Choice	At each agricultural season, the **process of management of the water resource** on the irrigated perimeter Tadla starts with the determination of the yearly water available by ORMVAT. The provisional irrigation program allowed the ORMVAT starting the agricultural season. If the real contributions are in conformity with the estimation, the program continues; otherwise it is actualized and the restrictions or increases are applied to the foreseen endowments.

PORTUGAL	
Setting	In the Caia catchment the focus must be the support to solve the problem of the **scarcity and irregularity of the water resources** available to supply, mainly, the irrigated agriculture and the domestic consumption. As a consequences of the **Dam Management**, the life conditions, the efficiency of water use, the conflict between users and some biophysical conditions (water remaining in the dam; Minimum Vital Stream and Stream Flow), might be change.
Actor and Problem Analysis	In Portugal, in the Caia catchment, most conflicts fundamentally arise during periods of **low rainfall** what makes it necessary to take measures in order to safeguard reserves for **domestic consumption** and to respect the **ecological flow** of Guadiana river, in detriment of agricultural use. On the other hand, focus of **diffuse pollution** result from spilling and infiltration of waters from soils with an intense agricultural activity and some shortcomings can also be noticed in the **treatment systems** for urban and industrial wastewater. Due to the geographic situation of the catchment under analysis, the **trans-boundary** question is particularly relevant because of the usage of water by Spanish farmers. The **actors** involved are the responsible entity for the ordnance of the dam (INAG), the municipalities (which are responsible for the treatment and distribution of water for domestic consumption) and the ASSOCIAÇÃO DE BENEFICIÁRIOS DO CAIA (Caia Irrigation Board), which is responsible for the distribution of all the water from the dam.

Policy/Decision Design	A **participative approach** has been set, involving Stakeholders at different levels and a **Social Network analysis** has been drafted. The objective was to understand the relationships between stakeholders thanks to series of 14 interviews targeted to the actors listed above. Thinking in the dimensions of the Caia's basin, after consulting end users (INAG and IHDRA – key stakeholders) and according to the socioeconomic characteristics was intended that 14 was a right number of to know the water resources problems and the interactions moved by its subject. Based on this framework **three different alternatives** to manage the Dam reservoir in order to solve the problem of scarcity of water were defined. These alternatives for Caia's reservoir representing three different assumptions regarding the achievable future of then dam: • **Strongest controlled reservoir: current situation** This alternative results from the trends in relation to climatic conditions and dam management options observed in Caia's catchment between 1960 and 1990. Based on this strongest controlled alternative the dam's management continues though the flood season. • **Controlled reservoir** In this method to management the water resources available "the reservoir releases water as a function of the desired target storage." (SWAT User's Guide, 2003) The target release approach tries to mimic general releases rules that may be used by reservoir decision maker (End Users). For the target release approach, the principal spillway volume corresponds to maximum flood control reservation while the emergency spillway volume corresponds to no flood control reservation. In the non-flood season, no flood control reservation is required. During the flood season, the flood control reservation is a function of soil water content. The flood control reservation for wet ground conditions is set at the maximum. For dry ground conditions, the flood reservation is set at 50% of the maximum. • **Uncontrolled reservoir** Considering certain limits related with the average release rate, this uncontrolled alternative represent the reverse face of current situation. However, this alternative doesn't represent the absence of the dam. If the limits of uncontrolled reservoir will be reached the authority of the dam could intervene
Policy/Decision Choice	NA
Shortcomings	In the decision-making concerning the Caia Dam Management it could be important to consider a set of different subjects, different dynamics and different stakeholders. In this sense the Dam Management could be supported by the DSS as an essential tool in the transmission of the base rules fundamental to take a decision more sustainable. The water must be viewed in the framework of this case study, both in its natural state and in balancing competing demands upon it – domestic, agricultural and environmental - in a way that ensures sustainability of the resource.

SPAIN	
Setting	The river Tagus is the longest river on the Iberian peninsula and the third with regards to total contributing area (about one ninth of Spain) and in amount of water carried (about one tenth of Spain). The Tagus Basin is the one that has the largest population weight in Spain and in the Iberian peninsula (over 6 million people). The volume of water that provides to other basins is a concern, since the Tagus is the one that provides the largest share to other basins. The Tagus basin is the most regulated one (about one fourth of the regulated water in Spain is from the Tagus Basin).
Actor and Problem Analysis	Historically, two groups of users have been in conflict over **water use** in the Tagus basin: the urban water supply companies and the irrigators
Policy/Decision Design	The Sacramento model reproduces streamflow from rainfall observations. It has been calibrated in the Tagus unaltered basin, and is used to generate runoff series for the 216 sub-basins for the period 1940-41 to 2000-01. It is estimated that the synthetic series contain the same hydrologic information as original records do and can therefore be used in drought analysis. Historical information of stored water in basin reservoirs is compiled for 46 major reservoirs in the basin. These data are processed and recomputed with the aid of water resources system simulation models to generate the synthetic series of stored volume assuming that all water demands In the Tagus basin the **operational indicators** to decide water allocation are the stored volume and the Surface Water Supply Index (SWSI). The Surface Water Supply Index (SWSI) has the advantage of combining hydrological and climatic features in a single index and allows for the consideration of reservoir storage, very important in the Tagus basin. Each component is assigned a weight depending on local conditions. These weighted components are summed to determine the global SWSI value for the entire basin.. The SWSI is computed for the 14 hydrologic zones in the Tagus basin, assigning equal weight to all three components. Precipitation and runoff are computed as spatial averages over the basins. Stored water is estimated using the water resources system simulation model, since historical values of reservoir storage do not correspond to current basin conditions. Threshold values of -2 and –3 of SWSI have been chosen, corresponding to moderate and severe drought respectively. Water management is always ultimately dependent of the **Basin Authorities** which have developed contingency plans with **three components that rely on DSS**: a) Definition of the triggers of the contingency actions. This initial step relies in the monitoring of key indicators that are based both in observational data and on modelled data by DSS. (b) Evaluation of possible contingency actions. This second phase relies in the results of scenario evaluation based DSS, such as the Aquatools set of models and (c) Implementation of the contingency plans. This final phase integrates the previous ones to formulate the Water management plans and includes DSS that incorporate policy aspects. This process is also followed by the main local water supply systems, such as the Canal de Isabel II.
Policy/Decision	**Basin Authorities** take decisions in **collective bodies**, although the executive

Choice	responsibility is held by the Chairman of the Basin's Authority. Reservoir Release Commissions are responsible for the continuous management of reservoirs. Under severe scarcity conditions, a Permanent Committee is appointed to manage the situation. As in any other River Basin Authority, the planning process is exposed to public scrutiny. Concerned individuals and social or political groups can make allegations that affect the planners´ decisions as in the Tagus Basin where the Office of Planning generates and analyses simple scenarios.

SYRIA	
Setting	The main river in the Asnober basin is the Asnober river which has a length of about 50 km, draining an area of nearly 270 km^2 into the Mediterranean sea, whereas surface water is the main source of water in the coastal basin. A number of 32 river systems drain the mountains area. The reservoir Al-Thawra have been designed in the 80s by the Bulgarian company Agrocomplect and were built from 1989 to 1995; it now a central system for the current water resource system in the basin.
Actor and Problem Analysis	Now it is intended to **build a new reservoir** with the priority of flood control and water supply to the Al-Thawra reservoir will also be enhanced.
Policy/Decision Design	The **River Basin Model software** package used in support of Decision Making is WEAP . It is applicable to municipal and agricultural systems, single sub-basins or complex river systems and other issues such as demand analyses, water conservation, water rights and allocation priorities, groundwater and stem flow simulations, reservoir operations, hydropower, pollution, ecosystem requirements, and project cost-benefit analyses. The implementation of WEAP in the Asnober Basin foresees several variables such as Scenario development, Economic growth , Environmental issues
Policy/Decision Choice	The Syrian regime gives priority to security, that means the **final decisions are made by the Syrian President** at all levels (especially National level), by the **Security Council** at all levels (especially in the counties and regions), and by the **party groups** at local level. The decision was supported to keep the social balances and because the Baath Party was a socialist party, that means to look to lower classes for fighting the poverty. This means also that the **stakeholders were not included** in the final decisions.

TUNISIA	
Setting	Situated to the Southeast of Tunisia, the plain of Djeffara spreads from the region of Skhira to the North of Gabès until the Tripolitaine in the South, on a surface of about 10,000 km2. The whole of the Tunisian Djeffara Tunisian is subdivided in two zones that follow each other from the North to the South: Djeffara of Médenine and Djeffara of Gabès, our case study, which covers about 3,000 km2.
Actor and Problem Analysis	Our case study concerns a **zone of interdiction of groundwater exploitation**. The "interdiction" decision is based on several studies showing that the intensive exploitation of the inshore aquifers of Jeffara risked causing, besides considerable resources decreases, an important deterioration of water quality by salinity increase and especially a serious marine intrusion. The **actors** concerned are the following: DGRE for Water management, SONEDE for rrinking water, Gouvernorat Legislative issues, CRDA, CIF and ADA Mizrâa Agriculture production, Desalination Station. The **population** of this region don't accept to be deprived of "their" water and **don't understand why they have to pay** to obtain limited volume of water for their agricultural activities when they can directly abstract all water needed by a simple well located on their parcel.
Policy/Decision Design	NA
Policy/Decision Choice	The decision was made progressively by **first the creation of a protected perimeter** (decree n°85-1105) in 1985 that was then spread and transformed in a **perimeter of interdiction** (decree n°87-480) in 1987. Decision making processes are traditionally restricted to the first level of stakeholders (ministry and state secretariat), although national strategies involve so called **"participative actions" but only for the application of the decision**. That's why, in the presented case study, the farmers have limited confidence in of the importance of the interdiction perimeters.
Shortcomings	A clear cut between national (governorate), regional (CRDA) authorities and end users of water (Association of Collective Interest : ACI) is noticeable. The relationship connecting regional (CRDA) and end user are denser but mainly axed on technical support. However, relationships within end users are well developed thanks to the ACI (association of Collectivist Interest): frequent meeting are organised and different problems related to water management are discussed. The presence of a regional responsible allows progressively making the decision more accepted by the farmers.

TURKEY	
Setting	The Gediz Basin in Western Turkey has changed considerably in the past decade, moving from a comparatively water rich basin to one that is now closing. This change has been in part a result of a severe drought that affected the Basin from 1989 to 1994, in part due to an above average increase in urban and industrial demand, and in part due to a rapidly growing concern for issues of water quality and environmental protection.
Actor and Problem Analysis	When the **drought struck**, irrigation issues in the peak summer season were reduced sharply, **return flows diminished**, and, as a consequence, **water quality** in the lower third of the Basin deteriorated. Rural residents began to complain that water was **unsuitable for irrigation**. At the same time there was widespread desiccation of the important **wetland areas** in the Gediz Delta, leading to large reductions in bird populations and, possibly, loss of species diversity. **Five categories of water users** in the Gediz Basin can be identified and their respective water uses outlined. In addition there are other **State actors** such as DSI involved in Gediz Basin water management which, while not water users, are important players. The main SHs of the region can be identified as: DSI, Ministry of Environment and Forestry, Municipalities and Villages, Provinces and Districts, State Planning Organization, General Directorate of Rural Services, Irrigation Associations, Other Irrigators, Environmental NGOs, Industries, Environmental Assemblies.
Policy/Decision Design	NA
Policy/Decision Choice	**DSI** is the major agency responsible for water allocation in the Gediz Basin. This task is assigned to DSI via its constitution law, Law No.6200 (Article 2), where DSI is designated as the responsible agency for planning, developing, managing and controlling the nation's water resources. Considering the water uses in the Gediz Basin, DSI also acts as the major decision-making and managing institution. DSI's decisions are realized in accordance with the master plans prepared to effectively exploit the water potential of the basin. The decision making process starts at the 2nd Regional Directorate of DSI and extends to the General Directorate for large scale projects.
Shortcomings	The current problem here is that, although DSI had been the sole actor to perform the **water allocation** task for long years, there are now **several new actors** who claim that this task is not assigned explicitly but only implied in Law No.6200. Since the constitutional laws of the new actors define responsibilities, which overlap with those of DSI, a significant conflict arises such that these new actors also claim their authority in water allocation. This is both an institutional and legal drawback. With respect to **water pollution**, the major drawback is again institutional and legal. In the legal sense, the problem is the existence of **too many regulations**, which treat pollution issues from a number of different perspectives. These regulations are often issued by different ministries and institutions. In the institutional sense, control of water pollution is in the hands of **4 different ministries**: DSI (Ministry of Energy and Natural Resources) monitors water quality but does not have an enforcement function; the Ministry of Environment and Forestry detects violators and reports them to the local governor; the local governor (Ministry of the Interior) is the only authority to issue fines on violators; the fines are collected by the Ministry of

	Finance, never to return to the environmental sector.