Polagwat

AGRICULTURAL WATER USE AND SECTORAL POLICIES IN MEDITERRANEAN COUNTRIES

Adeline Kroll (ed.)

with

Graham Russell and Clive Lipchin

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POLAGWAT RESEARCH PARTNERS

Institute for Prospective Technological Studies (Sevilla, Spain)	IPTS (JRC, EC)
Agricultural Economics Research Institute (Cairo, Egypt)	AERI
Agricultural Research Organisation (Bet Dagan, Israel)	ARO
Analistas Socio Políticos (Madrid, Spain)	ASP
Instituto Superior Técnico (Lisboa, Portugal)	IST
Istanbul Bilgi University (Istanbul, Turkey)	IBU
Blue Plan Regional Activity Centre, Mediterranean Action Plan (Valbonne, France)	UNEP/BPRAC
Universitá degli Studi della Tuscia (Viterbo, Italy)	UST

Main participants involved in the POLAGWAT project:

Name		**Task**
Adeline Kroll	IPTS	General co-ordination, general methodology (e.g., indicators of case studies), patterns of land ownership, Workshop co-ordination, synthesis and editing
Mahmoud Mansour	AERI	Scientific co-ordinator AERI
Nabil Habashy	AERI	Case study Egypt and Agricultural trade policy study
Clive Lipchin*	Arava Institute (Israel)	Relationships between policies and agricultural water use, Workshop moderator
Nava Haruvy	ARO	Scientific co-ordinator ARO, Case study Israel and and Agronomic and economic limitations study (with UST)
Marcel Fuchs	ARO	Scientific co-ordinator ARO
Sarit Shalhevet	ARO	Case study Israel
Berta Alvarez-Miranda	ASP	Case study Spain
Josu Mezo	ASP	Case study Spain and Government institutions and social agents study
Hein de Haas*	CIDIN, Univ. of Nijmegen (NL)	Workshop moderator
Sébastien Treyer	ENGREF and UNEP/BPRAC	Design for prospective phase (scenario)
Gun Kut	IBU	Case study Turkey
Cevdet Akcay	IBU	Water pricing
Ayse Deniz Ozken	IBU	Case study Turkey and water pricing
Ilter Turan	IBU	Scientific co-ordinator IBU
Francisco Nunes Correia	IST	Scientific co-ordinator IST and financial co-ordinator

Name		**Task**
Isabel Ramos	IST	Case study Portugal and EU agricultural, regional and environmental policies
Aline Comeau	UNEP/BPRAC	Scientific co-ordinator UNEP/BPRAC
Selmin Burak	UNEP/BPRAC	Major donor policies for Mediterranean irrigation projects
Patrice Miran	UNEP/BPRAC	Scientific co-ordinator UNEP/BPRAC
Rachad Antonius*	Univ. of Montreal (Canada)	Land ownership patterns in Egypt, workshop moderator
Graham Russell	Univ.of Edinburgh (UK) and UST	Agronomic and economic limitations study (with UST and ARO), editing
Raffaele Casa	UST	Case study Italy and Agronomic and economic limitations study (with ARO)
Benedetto Lo Cascio	UST	Scientific co-ordinator UST

** experts invited to the workshop*

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ABSTRACT

Keywords: water, agriculture, irrigation, policy, demand management, Mediterranean

The project POLAGWAT[1] was carried out by partners from eight institutions and six Mediterranean countries that represented a wide range of environmental, political and social situations. The aim of the work was to contribute to the sustainable management of water resources in Mediterranean countries through integrated, multi-disciplinary planning. It aimed to identify policy factors encouraging farmers to use large quantities of water and to evaluate the technical and economical feasibility of managing agricultural water demand by modifying policy in a range of sectors.

Work proceeded in a series of co-ordinated phases within an agreed methodological framework. The first part involved the production of reports on each of the six countries on the state of agricultural water use. The next phase was investigation in more depth of topics that were considered important drivers of change. These were: major donor policies for Mediterranean irrigation projects, European Union agricultural, environmental and regional policies, agricultural trade policy, relationships between government institutions and social agents, water pricing, land ownership patterns and agricultural water use, agronomic and economic limitations. These horizontal studies were intended to include information about other Mediterranean countries. The third phase involved the development of scenarios involving demand management for each country and an analysis of the likely consequences for agricultural water use. Finally, there was a workshop that built on the previous work and examined the priorities for research.

All the phases were achieved although a variety of problems arose. The Country studies were all completed and provided useful information although the information needed to fulfil the agreed specification was often unavailable. Nevertheless the trends in agricultural water use were identified. All the horizontal studies into the key issues were completed. However, there was less exchange of information between groups than had been hoped for and some issues were very particular for some countries. The scenario phase methodology was developed but it was quite difficult to put into practice due to unfamiliarity of the partners with this type of work. It also became clear that although the importance of demand management was often recognised, existing policies often did not take this into account. Nevertheless, this phase provided a valuable opportunity to test the feasibility of employing this methodology. A workshop was organised under the premises of the project in order to validate the project results, exchange views with participants outside the project and create a network on water, land and policies in the Mediterranean. The workshop worked well and allowed discussion of the reasons why inter-disciplinary work, as in this project, is so difficult to do well.

Detailed conclusions are given in the report. However, the main conclusions are:

1. The extreme variation in environment, political and social situation and history between countries and even regions means that policies will have to be carefully adapted to the local situation.

2. It is generally agreed that demand management measures will have to be brought in at some stage. A variety of policy instruments are available for this purpose.

3. Involvement of local stakeholders is important but should be within a regional or national policy framework.

4. A strong conceptual framework is required for success in inter-disciplinary projects as well as mechanisms for ensuring effective communication between disciplines.

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EXECUTIVE SUMMARY

The objective of the POLAGWAT project was to contribute to the sustainable management of water resources in Mediterranean countries through integrated, multi-disciplinary planning. It aimed to identify policy factors encouraging farmers to use large quantities of water and to evaluate the technical and economical feasibility of managing agricultural water demand by modifying policy in a range of sectors. The project was carried out over a four-year period from September 1998 until August 2002. Eight institutions participated in POLAGWAT: IPTS (Sevilla, Spain), the Agricultural Economics Research Institute (Cairo, Egypt), the Agricultural Research Organisation (Bet Dagan, Israel), Analistas Socio Políticos (Madrid, Spain), Instituto Superior Técnico (Lisboa, Portugal), Istanbul Bilgi University (Istanbul, Turkey), Mediterranean Action Plan - Blue Plan Regional Activity Center (Valbonne, France) and Universitá degli Studi della Tuscia (Viterbo, Italy). The POLAGWAT partners formed a multidisciplinary research consortium with expertise from the social sciences and economics as well as the natural sciences and engineering.

The Mediterranean countries are increasingly beset by problems of water shortage. In some countries it is possible to increase supply but in others reduction of demand is the only option. The greatest demand for water is from the agricultural sector, which is the basis of the economy and the social structure in many Mediterranean countries. At the same time the domestic sector including tourism is becoming increasingly important and this is leading to difficult problems of allocation of water.

There are ways of reducing the water used in agriculture without affecting production seriously. However, in many situations, farmers do not choose to implement these techniques. Part of POLAGWAT was to investigate why this is so and to identify particular policies that were responsible for this inertia.

The governments in the region are well aware of these problems and most have started addressing the issue. However, their attention is generally focussed on augmenting supply with engineering works and not on ways of reducing demand.

The work of POLAGWAT was divided into four interlinked components:

1. investigations of the factors affecting agricultural water use in each of the six partner countries (Egypt, Israel, Italy, Portugal, Spain, Turkey). This objective depended on the identification of appropriate indicators of water use. This part of the work also involved a comparative study of the countries.

2. in-depth studies on seven issues that were considered important drivers of agricultural water use in the Mediterranean countries. These were: major donor policies for Mediterranean irrigation projects, EU agricultural, environmental and regional policies, agricultural trade policy, relationships between government institutions and social agents, water pricing, land ownership, and agronomic and economic limitations.

3. analysis of the likely impact of policy changes (scenarios) on agricultural water use. It was assumed that scenarios would involve significant elements of demand management as the current situation was considered unsustainable.

4. Evaluation of ways of introducing policy changes and of identifying future lines of research.

From data on agricultural water use to the use of indicators

It proved surprisingly difficult to obtain consistent data on agricultural water use and the associated policy drivers. Data comparability between countries can be complicated by differences in data collection and analysis caused by different priorities, resources and skills. Limitations include unavailability of data (i.e., not collected, or collected but not compiled or distributed, or of uneven quality, not reported in a useful and consistent format etc.) and the lack of standardised methods between countries, within a country, and even from year to year. Some relevant information is not formally published but can be obtained, with effort, from the grey literature and from consultations with experts. In some cases, surprisingly large discrepancies were noted between information obtained in international databases and the information collected in the national studies.

Adequate and compatible data are required both for local management of water supply systems and to monitor the wider effects of policies and it is important to be aware of the reasons for their lack. These fall into two broad categories. There are often environmental reasons for a lack of comparability between data. These include climatic and soil conditions, cropping patterns and whether water comes predominantly from surface sources or groundwater. Data can be used effectively for local management or for the monitoring of trends over time but may not be appropriate for making comparisons between regions or countries. The institutional and political reasons are directly related to the cost of data collection and analysis (measuring water use is expensive – the only country carrying out water data collection on a consistent and regular basis is Israel), the strategic value of water, and the degree of institutional experience in collection, analysis, and dissemination of data. In these cases the degree of reliability of the figures is low. Even in this case, however, it may be possible to establish tends. In fact, in the present study an analysis of trends based on the available data collected by each country proved to be more important than focusing on the variability of the data caused by the source.

There is an increasing need to have more comprehensive data on water resources and on water use while the costs of good-quality fieldwork are high. However, modern technologies (telemetry, satellite remote sensing, GIS, simulation modelling) should be able to overcome some of the measurement problems. Another complementary approach is to establish common definitions for indicators of water use specifically chosen for the Mediterranean context, as was done in the present project.

Characterisation of agricultural water use in each country

The countries and issues studied

The six countries studied showed some similarities but differed in terms of land ownership, control over water resources, availability of groundwater, rainfall amount and reliability, and degree of intensity of agriculture and its market orientation. Although there are many external influences on the exploitation of water resources, for example treaty obligations, international agreements, trans-boundary issues and the global economy, the way in which these issues are dealt with depends on the political and socio-economic situation in each country. To a lesser extent this is also true of data collection as some countries have a long history of centralised collection of agricultural data while others have not. Although the amount and quality of available information varied considerably, it was still possible to assess the state of irrigated agriculture in each country and to identify the key issues affecting the future evolution of trends. Because the partner countries covered virtually the full range of environmental and social conditions in the Mediterranean countries, the key issues relating to water use were covered in at least one country study with the exception of long term utilisation of fossil water resources, which is mainly an issue for Libya.

Overall situation

The overall situation in the Mediterranean countries as a whole is characterised by extreme variability as discussed above. However, the sustainability of irrigated systems is becoming an issue in all countries even though the reasons for concern vary. Irrigation systems are only sustainable if:

- water of adequate quality is available at the right time and in sufficient quantity,
- the system is profitable to the farmers,
- negative impacts on the environment are tolerable both in terms of international obligations and acceptability to other stakeholders.

In countries such as Egypt and Israel almost all the resources are used completely and any expansion depends on using water more efficiently and re-cycling wastewater. In Israel, the most efficient schemes operate at close to the theoretical maximum efficiency and any progress will have to come from changing the crops grown to ones that make better use of water. In other countries, there is scope for increasing the efficiency of water use considerably. This does not necessarily mean changing the irrigation technologies, as maintenance of distribution networks, monitoring water used, and training of farmers and technicians also provide opportunities for saving water. A major issue is the price of water, particularly in view of the increasing water needs of the domestic sector and for environmental protection. This, along with other important issues was investigated during the next phase of the work.

Perhaps surprisingly, none of the groups raised the issue of climate change although any diminution of rainfall or decrease in reliability will pose a serious threat to irrigated agriculture.

Key issues affecting agricultural water use

Together the partners had experience of a wide range of policies and management structures and their. However, although each partner provided at least some information for one or more of the seven key issue studies, there was less sharing of information than had been expected, partly because some issues were perceived as being of less importance in some countries, and partly because many of the studies were focused strongly on the conditions in the country of the partner responsible for the study. This was probably inevitable given that the partners had naturally most experience of conditions relevant to their own country. Indeed, one of the results of the studies was the diversity of the key issues affecting water consumption between and even within countries. Although the partners were more effective in identifying key issues than in quantifying the trends, conclusions were arrived at that could be used to predict the affect of changes in policy in particular situations. In some of the studies, it proved extremely difficult to obtain quantitative data at an appropriate scale. The issue of scale is an important one. Data aggregated for Italy as a whole, for example, hide the very real differences between the north and the south.

The key conclusions of each study are listed below.

Major donor policies for Mediterranean irrigation projects

- less money for irrigation
- more money for rehabilitation and the development of existing systems
- wider assessment criteria
- support for more sustainable irrigation
- more effective organisation of irrigators' groups
- carefully piloted micro–drainage schemes are needed
- cost recovery from farmers is increasingly important

EU agricultural, environmental and regional policies

- EU policies have had an important influence on water consumption in the agriculture sector of the Mediterranean EU countries
- the CAP and Regional Development funds have encouraged large scale irrigation
- EU environmental policies and external market pressures are likely to result in a reduction in irrigated area and an increase in the efficiency of water use
- there are differences between countries in the way EU legislation has been applied
- there is a lack of communication between the agricultural and environmental sectors
- integration among policies, sectors and people is necessary for a balanced and sustainable solution

Agricultural trade policy

- subsidies, quotas and tariffs, which can distort water use, are still in widespread use in the Mediterranean region

- most Mediterranean countries, with the exception of Israel, either give hidden subsidies for water used for irrigation or completely subsidise water for agriculture
- developed countries need to address the negative effects of trade liberalisation on Mediterranean countries.
- the main agricultural exports from Mediterranean countries to the EU are fruit and vegetables, which are heavy users of water.
- encouragement of organic agriculture in the Mediterranean countries will help to put the region in a competitive position with respect to agriculture exports as well as having environmental benefits
- the revenue per unit of applied water is an appropriate basis for optimising cropping patterns in Mediterranean agriculture
- however, there is not yet an effective way of incorporating environmental costs into policy

Relationships between government institutions and social agents

- official markets for water are poorly developed in the Mediterranean countries
- low-level management water organisations are usually self-governing and can be very effective
- high-level management is invariably by state institutions
- inefficiencies in water use are encouraged by non-observance of the principle of proportionality
- some water management systems that are considered highly successful in terms of sustainability and avoiding conflicts between users are not very efficient in terms of water consumption

Water pricing

- pricing of agricultural water must be based on sound economic principles.
- the adoption of reforms based on the principles of "full cost-recovery" and "user-pays" may be hindered by political, social and cultural traditions and the structure of agriculture.
- the key to success in pricing reforms is to be aware of these constraints and to take account of local problems and priorities when formulating the pricing policies.
- in a few circumstances, pricing may not be an effective management tool.

Land ownership

- the concept of ownership needs to be defined carefully as it involves more than property rights
- the definition of private, public and common property can differ between countries and cultures
- there is no clear link between farm size and productivity
- water rights and water supply structures seem to have a greater impact on water use efficiency and thus farm productivity than actual property rights

Agronomic and economic limitations

- there was considerable variation between and within countries in their overall efficiency of water use and in the particular factors resulting in inefficiency
- agricultural, technological and delivery efficiencies can be defined unambiguously and used to identify sources of inefficiency and monitor the effects of policy changes
- much of the information required is not routinely collected in a standardised manner and where it is collected it is often aggregated at an inappropriate scale
- economic and Social efficiencies are difficult to define and their use is complicated by the differing social and economic objectives of the partner countries
- environmental efficiency is not a very useful concept as environmental policies are generally based on thresholds, which vary according to the conditions in each country
- it is possible to achieve efficiencies near the theoretical maximum but there may be unacceptable economic, social or environmental consequences

Regional infrastructure development and education and extension policies were not treated explicitly. However, the former was touched on in the sections on major donor policies and on EU regional policies while education and extension work influencing water consumption is often not a result of specific policies but rather a consequence of other activities such as capacity building or water management. It was interesting that several of the partner countries did not actively manage water demand because the physical limitations to the availability of water were not recognised by policy makers.

Although climate change was not one of the key issues in this project it has been well studies elsewhere. The prognosis is not clear, but any significant diminution of rainfall is equivalent to a reduction in the available resources and will have a large effect on irrigated and rain-fed agriculture in those parts of the Mediterranean region where existing resources are almost fully utilised already.

Many of the studies turned out to be less independent of one another than expected. For example, the water pricing and trade policy studies were linked through the principle of full-cost recovery. Some overlaps were removed in the editing phase and some material was transferred between sections. As was alluded to in some studies, agricultural water use cannot be divorced from water use as a whole. In some parts of the Mediterranean region there is already strong competition for water between agriculture and domestic sectors. Another topic that was mentioned is the affect of the availability and cost of transport on the types of agriculture practised. Much of the produce of the Mediterranean region is exported to the markets of the north and depends on the provision of cheap, rapid transport. The environmental costs of transport are increasingly coming under scrutiny but vary considerably with the mode of transport used.

From water supply to water demand: the prospective approach

The essence of this method was to develop scenarios, i.e. a set of policies and situations, for each country, and then to investigate the impact of these policies on overall water use by agriculture using information gathered in the first two phases. It had been expected that policies would involve elements of demand management. However, it soon became clear that in many countries demand management does not play a major role in policy making and indeed the concept of scenario generation was not widely used. National political decisions generally aim to provide the works needed to avoid infrastructure constraints on the development of irrigation. It seems to be clear that for nearly every agricultural or irrigation planning agency in the region the planned development of irrigation follows the most optimistic scenario of agricultural water use evolution.

It was found that there are many reasons why demand management policies are not implemented. One, of course, is that no need is felt for them. However, even where the need is appreciated there can be formidable obstacles to their adoption including political acceptability of preventive demand management measures, national political choices preventing demand management at a regional scale, and power relationships within a planning process. Additionally, factors external to the decisions of the national water and agriculture policy makers can have a major but very uncertain influence on future agricultural water use.

We investigated water scarcity and demand management in the agricultural sector by asking the following two questions:

1. given that the development of irrigation does indeed follow the optimistic trajectory, will this be an efficient use of water?

2. if, as seems likely, this assumption proves wrong then will the effort put into this development have been a better investment than making the agricultural sector more adaptive to change?

The first set of recommendations made during the scenario phase was very much linked to the technical or economic solutions for improving water use efficiency that would be acceptable to farmers, and which thus could be implemented successfully. At that stage, a discussion on recommendations could not take place between the various country teams and so it was not possible to identify at the country level the ways of altering the socio-economic and political situation in order to make demand management more feasible. We were, however, able to consider these changes more generally.

Water saving solutions

The partner teams considered water saving solutions using the criteria of usefulness, feasibility and acceptability, rather than the criterion of a contribution to the implementation of demand management. The following guidelines were developed:

1. The choice of measures needs to be adapted to the regional situation (stage of mobilisation of the resources, political context, climate, agricultural sector strength, etc.).

2. The same is true of organisational change as the success of a particular solution depends on the historical development of the agricultural sector in the region of interest.

3. Water saving solutions at a local level do not necessarily lead to an overall increase of efficiency. For example, water losses from local farming systems in Egypt can be re-used further downstream and also permit effective leaching of salts. The systemic efficiency may be high at a regional level even though the local efficiency is low.

4. In some cases, water use efficiency has been increased by re-organising the irrigation sector into water users' associations.

5. Water pricing policies should be implemented gradually, beginning with the installation of water meters, then instituting a price per volume used (rather than per irrigated area) and ultimately recovering an increasingly high proportion of the real costs.

6. Consider putting a value on water by permitting the selling of water quotas to urban or other users (from agricultural to urban users for example). However, this needs to be carefully piloted and tested beforehand and a strong administrative structure put in place. Such a procedure would be useful in Israel where a market for water quotas may be set up.

7. Investment in the treatment of urban wastewater can reduce the demand for high quality water by agriculture.

Conditions for policy change

We have investigated the conditions that favour the political acceptability of demand management. The rather erratic pathway from policies oriented to resource development to demand oriented ones can be summarised as follows:

1. A rather general feature of agricultural water use is that external pressures in general encourage the growing of particular crops or the adoption of particular cropping systems that may not be efficient users of water and that this can lead to a perception of scarcity of water or of unsustainability for agriculture in general.

2. The traditional solution was to increase the mobilisation of water resources, an option no longer available to many Mediterranean countries.

3. More recently emphasis has moved towards conserving water by decreasing water use per capita or by recycling.

4. However, these two solutions appear not to be problem solving, for at some point resource development will lead to water becoming too costly for agriculture, and for water conservation if the water-using activity keeps growing then water demand will keep increasing and the onset of scarcity will only be delayed.

5. The only solution left is one that has been rejected before because it was too difficult to implement: a policy change towards real demand management.

6. Thus, the logical evolution over time of agriculture and water policies seems to result in questioning the justification of past and present resource development policies.

7. The conditions for this policy change are the acceptance of the necessity for doing this. This may come from internal or external pressures.

Future research lines

Future research lines were considered at a workshop held in Brussels. The participants were not only drawn from the POLAGWAT members but included experts working in other Mediterranean countries. One of the motivations for the meeting had been the need to discuss the dynamics of multi- and inter-disciplinary projects, such as POLAGWAT, including social, economic, institutional, technical and scientific dimensions of policies. Background papers were prepared for the meeting and circulated beforehand.

The group discussed the distinction between inter- and multi-disciplinary research and the advantages and disadvantages of each. Multidisciplinary research involves disciplinary groups working independently towards a common goal where as interdisciplinary research shares a common methodology between disciplines. The latter, of which POLAGWAT is an example, was felt to be more difficult to organise but to hold a better possibility of success. A key problem to be overcome is the problem of communication between disciplines caused by the use of different technical terms and methodologies and often by the use of different spatial and temporal scales for an analysis. Ecology holds out the possibility of the core discipline for integrating knowledge. It is important to understand the nature of human behaviour and to take into account power structures in a society as this affects crucially what is possible to achieve.

A framework for organising such research on patterns of resource use from an organisational or institutional perspective involves a sequence of phases: description, causal analysis, meta explanation (reasons for actors making policy changes), development of policy orientations. In fact this structure is close to the one adopted in POLAGWAT.

The participants proposed guidelines for carrying out inter-disciplinary research:

- Track changes in institutional settings that define access to and use of land and water resources, and identify the active agents pressing for change.
- Address the issue of how water rights, prices and incentives for efficient use are allocated, used, and how they are perceived by both policy makers and users.
- Examine the relationship between communities and the state bureaucracies in terms of the control of the resource and decision-making.
- Study how knowledge of the functioning of local collective water management can be established and shared and link the actors with the mode of management.
- Find how water is managed at the local level, e.g. by establishing the “working rules” that regulate local water management, taking into account the historical origin and evolution of the property regimes governing water.
- Address the nature of conflicts around water use particularly those where regulations constrain the activity of some stakeholders.
- Develop and test techniques for assessing the status of the environment in wetlands that can be used in all parts of the Mediterranean countries.
- Establish how the economic and social relationships within the local rural society, the market and local services of the public administration affect policy implementation and the administration of water use.
- Make explicit the modes of disengagement of the state, where this is seen to occur, with its move towards different forms of exercising power, such as a decrease in authority.

General conclusions and recommendations

General conclusions and recommendations are given in chapters 7 and 8 and have not been repeated here.

Chapter 1

1. INTRODUCTION

This report summarises the main findings of the POLAGWAT project (Sectoral policies and the use of water by agriculture in the Mediterranean). POLAGWAT is an interdisciplinary, EC-funded research project studying the relationships between sectoral policies and agricultural water use in the Mediterranean. Its objective is to contribute to the sustainable management of water resources in Mediterranean countries through integrated, multi-disciplinary planning. It identifies policy factors that encourage farmers to use large quantities of water and evaluates technical and economical feasibility of managing agricultural water demand by modifying policy in a range of sectors. This research has been achieved by comparing the socio-economic, agricultural and environmental parameters, which condition the use of water in agriculture in six Mediterranean countries.

The POLAGWAT project was initiated and co-ordinated by IPTS (JRC, EC). The project proposal was approved for funding by the INCO-DC programme of DG Research from the European Commission in 1997 (contract number IC18-CT97-0165). The project was conducted over a four-year period, from September 1998 until August 2002. Seven other institutions participated in POLAGWAT in addition to IPTS. The following institutions were part of the project: the Agricultural Economics Research Institute (Cairo, Egypt), the Agricultural Research Organisation (Bet Dagan, Israel), Analistas Socio Políticos (Madrid, Spain), Instituto Superior Técnico (Lisboa, Portugal), Istanbul Bilgi University (Istanbul, Turkey), Mediterranean Action Plan - Blue Plan Regional Activity Center (Valbonne, France) and Universitá degli Studi della Tuscia (Viterbo, Italy). Together, the POLAGWAT project partners comprise a multidisciplinary research consortium, with expertise form the social/economics as well as the natural sciences and engineering background.

Mediterranean countries are increasingly host to problems of water shortages: demand for water is commonly higher than available supply and towns are frequently subjected to water cuts. In some places, activities are underway to increase the supply available to users. In much of the Mediterranean, however, this is not technically or economically feasible. The only way to make the supply equal the demand is to decrease the demand in one or more sectors. The greatest demand for water in the Mediterranean, by far, comes from the agricultural sector, accounting for more than 80% of water withdrawals. Furthermore, agriculture has a very specific seasonal demand pattern that is often conflicting with other uses. Since agriculture is the basis of the economy, and of the social fabric, in many parts of the Mediterranean, it must be maintained. However, with increasing demands for water from other users, these countries can no longer afford to devote such a large amount of their water resources to this sector.

Fortunately, however, although agriculture certainly requires large quantities of water as a raw material, there are a variety of options for reducing the amount of water needed. These include the use of more efficient irrigation technologies, the choice of farming systems that conserve water, and the decision to plant crops with lower water needs or naturally adapted crops. Nevertheless, in most areas, farmers do not choose to implement these options for making more efficient use of water. While in most countries, it is the individual farmers who make these choices, they are influenced by a wide variety of factors. Frequently, the driving factor is government policy in sectors that are seemingly far removed from water management.

The governments in the region are well aware of their water problems and most have started addressing the issue. However, their attention is generally focussed on possibilities for augmenting supply with engineering works; less frequently, water managers may also consider issues such as water re-use, water pricing and other policy issues, but always within the "water sector" (which manages the capture, storage and supply of water to users). Policy in other sectors may have an equally strong impact on the farmers' decisions, yet has received little attention.

In order to understand the relationships between sectoral policies and the use of agricultural water in the Mediterranean, the first objective of the POLAGWAT project is to characterise agricultural water use in the six examined countries representing the Mediterranean basin[2]. With this first objective, the full range of sectoral policies (including agriculture, land use planning, regional development, energy, industry, education/training, trade ...) which directly or indirectly influence agricultural water demand were investigated Detailed attention was paid to the obstacles to introduction and implementation of water-efficient agricultural exploitation systems (Chapter 3). For each national case study, the use of agricultural water was characterised using three types of indicators: 1) related to irrigation, 2) water resource commonly accepted concepts, and 3) pressure indicators. To be practical, and since widely accepted definitions do not exist for all the indicators used, a glossary of terms was set up (Annex). The work on indicators also led to an interesting debate on the quality attached to water and agricultural data available at national/regional levels, as well as the relevance of the data found in the international databases (Chapter 2).

In addition to gaining a better understanding of the interaction between sectoral policies and the use of agricultural water in the examined countries, the POLAGWAT project sought to analyse sub-themes related to policy and agricultural water use. This was the second objective of the project where six "horizontal, thematic" studies were identified (Chapter 4). These topics included the interaction between the use of water in agriculture and: 1) major donor policies, 2) EU agricultural, environmental and regional policies, 3) agricultural trade policy, 4) governmental institutions and social agents, 5) water pricing, 6) patterns of land ownership and 7) agronomic and economic limitations.

As the third objective, the project aimed at analysing possible impact of policy changes on agricultural water use, based on a scenario analysis methodology (the prospective phase, Chapter 5). The underlying assumption was that scenarios would involve demand management, e.g. by water pricing and education. Currently, most countries manage supply, e.g. by investing in infrastructure, and this is considered to be unsustainable. Part of the work was therefore concerned with examining the importance of demand management.

[2] Three EU countries represented by Italy, Spain and Portugal. Turkey, Israel and Egypt represent in this project the Middle-East and Northern African countries (MENA).

The objective of the scenario phase was to examine the effects of interacting policies during the decision-making process that is agricultural water management. This complex interaction of policies is difficult to model, so investigations were made into the interaction of sectoral interventions within water policy formulation and the decision making process. Demand management scenarios were investigated by adapting scenarios contained in the national planning documents.

Finally, the fourth objective was to discuss alternatives for introducing policy changes and delineate future lines of research in this field (Chapter 6). The results and conclusions of the individual case studies, thematic and prospective analyses were used to provide an integrated picture of the conditions on the use of water in agriculture which prevails in the Mediterranean. These results were debated with other experts pertaining to other related projects invited to participate in a two-days workshop (Water, Land, Agriculture and Policies in the Mediterranean countries, Brussels, 19-20/04/02). The goals of the workshop were to discuss 1) modalities for multi-pluridisciplinary works, and 2) the patterns of use of water in agriculture in the Mediterranean. From these insights, a number of recommendations are derived pertaining to measures which might contribute to a critical analysis of the prevailing conditions for agricultural water use and potential alternatives to move towards integrated policy development promoting more sustainable water use in agriculture in Mediterranean regions (Chapter 7).

Chapter 2

2. FROM DATA ON AGRICULTURAL WATER USE TO THE USE OF INDICATORS

Introduction

The availability of reliable data is a necessary condition for the consideration of water consumption in agriculture. Data do not necessarily need to be comprehensive but must be of sufficient quality to allow appropriate comparisons to be made particularly trends over time and differences between locations (countries, regions and farming systems). Although at first sight there is a large amount of information available, e.g. via the FAO AQUASTAT database[3], its utility depends on the methods used to collect the data and the scale at which it is presented. The six countries involved in the project were considered representative of the range of physical and cultural situations of the Mediterranean countries.

Methodology

Information was gathered for the six partner countries and compiled in country reports.

Country reports

A single questionnaire was designed to obtain the values for a wide range of quantitative and qualitative indicators relevant to trends in the use of water in agriculture and the reasons for any change. The initial list was compiled by Plan Bleu for analysing the use of water in Mediterranean agriculture. However, other indicators were added to broaden the issues considered. The complete list is given in tables 1 and 2. The national teams collected the relevant information by referring to official statistics and consulting local experts. Since common definitions of indicators are essential for making comparisons between countries a glossary (Annexe 1) was produced to facilitate consistency. Each country outline report, or national case study, was based on the results of the questionnaire although partners were able to modify their procedures within this overall framework to take account of differences between countries in the relative importance of policy goals and in the way information was collected.

[3] http://www.fao.org/ag/agl/aglw/aquastat/main/index.stm

Description		***Indicators***
1. Agricultural systems		1. Rainfed/irrigated area
		2. Percentage of employment generated by agriculture
2. Irrigation and drainage development	2.1. History and Evolution	3. Irrigated land/cultivated area
		4. Equipped area/total cultivated area and % of spate irrigation
		5. Volume of water used by agriculture, % of total
		6. Irrigated area by irrigation methods (gravity, aspersion, micro)
		7. Irrigated area by size (Large, medium, small schemes)
		8. Agricultural water consumption by water sources (surface, groundwater, re-use of water, saline waters)
	2.2. Main irrigated crops	9. Crop output per cubic meter of water supplied
		10. Area for major harvested irrigated crops
		11. Cropping intensity
	2.3. Irrigation role in economic development	12. Trends in food self sufficiency
		13. National Agricultural Gross Domestic Product from irrigated sector/total AGDP
		14. AGDP from irrigated agriculture/total GDP
		15. Water used by agriculture/AGDP
3. Different water users, potential conflicts		16. Per capita water availability, rate
		17. Per capita water demand
		18. Sectoral water demand
		19. Water exploitation index
4. Impact of agriculture on water resources		20. Salinised irrigated land /total irrigated land
		21. Overexploitation indicator for selected aquifers
		22. Loss of biodiversity
		23. Wetlands area / total territory
		24. Pesticide use/ha
		25. Fertiliser use/ha

Table 1: Quantitative indicators of agricultural water use

Topics	*Sub-Topics*	*Sub-Question*
2. Organisation of water management and water use in agriculture: Institutional and economic aspects	2.1. Organisation	2.1.1. Institutions
		2.1.2. Mgmt of agriculture sector
		2.1.3. Transfer of responsibility
		2.1.4. Water users associations autonomy
		2.1.5. Water delivery mgmt in irrigation scheme
	2.2. Available regulatory means	2.2.1. Ownership and water rights
		2.2.2. Land tenure and water use
		2.2.3. Available means for water demand management and level of application
	2.3. Socio-economic aspects	2.3.1.Water taxes on withdrawal or pollution
		2.3.2.Irrigation cost
		2.3.3.Water charge policy for irrigation
		2.3.4 Water saving techniques incentives
		2.3.5 Other means used
3. Present irrigation performance: efficiency of water use	3.1. Monitoring	
	3.2. Technical efficiency	
	3.3. Economic efficiency	
	3.4. Social efficiency	
	3.5. Environmental efficiency	
	3.6. Micro/macro efficiency	
4. Impact of past and current agricultural policies on agricultural water use	4.1. Agricultural policy and its consequences on water used by agriculture	4.1.1. Prime objectives;
		4.1.2. Measures in favour of irrigation;
		4.1.3. Measures to improve water efficiency
	4.2. EU agricultural policy and GATT (CAP, GATT)	
5. Impact of other relevant policies on agricultural water use	5.1. Regional development	
	5.2. Land use planning	
	5.3. Other economic sectoral policies (tourism, industry…)	
	5.4. Environmental policies (national and major donor policies)	

Table 2: Qualitative indicators of agricultural water use

The data were quality controlled by checking for internal consistency of the quantitative data, by comparing the results with international data sets (FAO, EC databases, ICID) and by comparing the data collected in the six country studies to identify discrepancies. The draft report of this phase was sent to the partners for verification.

Systemic study

This study was intended to be similar to the country outline reports but at a more general level. Although it was initially intended to use a GIS to organise the data, the lack of consistency of the information collected meant that the presentation of data from the system could be misleading. Instead the study took a more qualitative form in which the country outline reports were synthesised, indicator by indicator. Wherever possible, differences between countries were investigated in terms of their physical and socio-economic environment and links were made to other Mediterranean countries.

Results

Data were collected for each country but it proved more difficult than had been expected. Some of the reasons for this are given below. Guidelines for the use of indicators were also developed as a result of this experience.

Data comparability and reliability

The group debated extensively the comparability of the data collected by each country. Often data could not be directly compared for environmental or institutional and political reasons. The environmental reasons include regional, climatic and soil conditions, cropping patterns and water resource characteristics (i.e. surface water versus groundwater). For example, data aggregated at a country level are inappropriate for comparing water usage in Italy and Israel due to the large differences in rainfall and availability of groundwater between the south and the north of Italy. The institutional and political reasons are directly related to the cost of data collection and analysis (measuring water use is expensive and the only country of the six collecting routine water data on a consistent and regular basis is Israel), the strategic value of water, and the degree of institutional knowledge for dealing with data collection, analysis, and dissemination. For planning and policy purposes, however, it is often not the absolute values that matter but rather the trend over time as an indication of progress towards some goal. A more important issue was the consistency of the data within a country both over time and from source of information to source of information. It is important to justify the collection of all items of information so that a limited budget for data collection can be well spent. Some items of information need to be collected on a regional or river basin scale. For example, the average rainfall over a country is not useful if much of the rain falls in a part of the country where the water cannot be used.

Indicators

Some indicators were found to be more difficult to use than others, e.g., irrigation area by size, salinised areas, salinity and sodicity, cropping intensity, water balance, food self-sufficiency and food security, even though they had been debated, closely defined and documented. This was either because the data were unavailable or because the way the definition was framed was conceptually inconsistent with the way the information was collected. The indicator on wetland areas and biodiversity was hardly documented in the national case studies because the data were unavailable. Although both terms have been defined, they are actually very difficult to use in practice as slight differences in the definition or the methods used to assess them can have a large effect on the numbers produced. This was the reason why these indicators were placed in the qualitative category. However, for this type of indicator to be successful there needs to be some standard against which it can be compared. The problem of assessing the impact on biodiversity and habitat quality is not only one for irrigated agriculture as urban and tourism developments are also important for wetlands. Assessment methods should thus be compatible between sectors.

Criteria for choosing indicators

A considerable amount of work has already been carried out by other researchers into the use of indicators for assessing sustainability and identifying climate change.

Consistency over time

Trends can only be established reliably if the time series is consistent, i.e. carried out using the same methods and definitions or where, if there have been changes, the data have been homogenised by correcting to a common basis. This sort of procedure is carried out routinely for meteorological and hydrological data when the site of measurement changes. Where there is significant year-to-year variation in what is measured it is important that some data are collected annually even if more intensive measurements are carried out less frequently. Otherwise there is a risk of trends not being detected in time for action to be taken.

Sensitivity to change

Good indicators give early warning of trends. Data collected at a country level can hide major trends at a more local level due to the dilution of the indicator by information that is not likely to change. For example, the cropping intensity in a country such as Italy will always be close to 1.00 as double cropping is really only possible under irrigation and most of the crops are not irrigated. If 80% of the area is un-irrigated and all the irrigated land were to change from single to double cropping, for example, the ratio would only rise from 1.00 to 1.20.

Cost and ease of collection

Good data collection is always expensive unless the information is required for another purpose or the cost can be recouped as part of a charge for use of a service such as the provision of irrigation water. Some data collection can be automated thus changing the balance of costs from running costs to capital costs. There are some interesting ideas from the MARS programme developed by the JRC, Ispra for monitoring crop yields. Some data were modelled, others were collected using remote sensing (area of wetlands would be a prime candidate here) and some were collected from sample sites. It is often convenient to attempt to collect a complete set of data. However, it may be cheaper and more reliable to just monitor a statistically valid sample of locations. The ratio of irrigated land to cultivated land can be derived by dividing the area of irrigated land by the cultivated area or by multiplying the cultivated area (which is often known very accurately) by the ratio of the two quantities estimated from samples.

Appropriate scale

In some cases the overall country figures for indicators are of less important than those for key regions. There is perhaps a parallel here with soil survey, which has moved from the creation of maps based on sample profiles and the experience of the soil surveyors to the creation of databases from which maps can be derived for particular purposes. GIS technology is widely available and can be used for this purpose. Transfer functions were developed in geology to allow the estimation of values of some unknown parameter of interest from related data that are available.

Independence

Interpretation of indicators can be enhanced by ensuring that they are independent of each other and that one is not a necessary consequence of another. In the case of quantitative data, it can be useful to consider some indicators as the product of others. For example, the total area of irrigated crops is the product of cultivated area, the proportion equipped for irrigation, proportion of the equipped area that is actually irrigated and the cropping intensity.

Mathematical properties

Quantitative indicators are easiest to interpret when they are constrained to fit within boundaries. For example, the GDP from irrigated agriculture/total GDP must lie between 0.00 and 1.00. On the other hand, the ratio of irrigated to rainfed area for Egypt was 1326% and will tend towards infinity rapidly as the proportion of irrigated land increases. The effects of minor changes in irrigated area will be magnified in this ratio. Normalisation of data is not the only way of setting boundaries. Other indicators can be interpreted in terms of previously agreed thresholds or targets, e.g. the proportion of wetland in a region, or of some theoretical maximum. An example of the latter is water use efficiency, which has a theoretical maximum based on the physiological efficiency with which plants are able to use water to produce biomass and crop yield. The distribution of irrigated holding by size generated considerable discussion. It was developed as a qualitative indicator but in retrospect it may have been easier to use it as a quantitative one. What is required is a frequency distribution showing the cumulative area plotted against size of holding. This can be derived using complete enumerations or sample data and described in terms of the parameters of the resultant curve. The data collected in the present work can be transformed in this way. The benefit of doing this is that no value judgements are required as to the definition of large and that the proportion of area in any class of area sizes can be found.

Conclusions

Consistent data on agricultural water use and their policy aspects are hard to obtain. Data comparability, whether qualitative or quantitative, is affected by a number of factors identified at both levels of data collection and analysis. Limitations of the data include its unavailability (i.e., not collected, or collected but not compiled or distributed, or of uneven quality, not reported in a useful and consistent format etc.) and the lack of standardised methods between countries, within a country, and from year to year. Some information only exists in the grey literature as unpublished data sets or from expert consultations. National agencies collect data with different skills and traditions, priorities, and intents. Surprisingly large discrepancies were noted between international data sets, such as the ones of FAO, EC databases, ICID, and the national sources used in the national case studies even though the former are often derived from the latter.

The difficulties of obtaining compatible data can be traced to both environmental and institutional or political reasons. The environmental reasons include regional, climatic and soil conditions, cropping patterns and water resource characteristics (i.e., surface versus groundwater). In these cases it is not so much that the data is wrong but that it is difficult to separate out trends from the other factors causing variation. The institutional and political reasons are directly related to the cost of data collection and analysis (measuring water use is expensive – the only country carrying water data collection on a consistent and regular basis is Israel), the strategic value of water, and the degree of institutional experience in collection, analysis, and dissemination of data.

Alternative and practical approaches to deal with the current problem of data comparability include the use of indicators with common definitions specifically chosen for the Mediterranean context. In fact, an analysis of trends based on the available data collected by each country proved to be more important than focusing on the variability of the data caused by the source.

There is an increasing need to have more comprehensive data on water resources and on human water use while the costs of good-quality fieldwork are high. However, modern technologies (telemetry, satellite remote sensing, GIS, simulation modelling) should be able to overcome some of the measurement problems. Although derived data should not be used in isolation from measured data, its use could resolve the problem of unavailability of certain data by making assumptions and deriving values from other available data.

Chapter 3

3. CHARACTERISATION OF AGRICULTURAL WATER USE IN EACH COUNTRY

Introduction

The objective of the chapter is to understand the present situation of agricultural water use, as well as the socio-economic and political factors which condition it in the Mediterranean basin. This chapter summarises the first phase of the project where national case studies were performed for Italy, Spain, Portugal, Egypt, Israel, and Turkey. The impact of measures taken in certain countries to increase the efficiency of agricultural water use has also been examined in each country. Only contrasting examples (boxes) were chosen to illustrate this summary as detailed information and tables can be found in the Annual Report 1999 of the project (Annual Report 1999, Kroll, A. ed. 2000).

In order to characterise the use of agricultural water in the examined countries, indicators were chosen to compare the use of agricultural water across the countries with a common baseline. As explained in Chapter 2, a glossary of each definition was set up.

This chapter is divided into two sections, 1) Agricultural water use and 2) Institutional and economic aspects of the organisation of water management and water use. Section 1 gives an overview of the use of water in agriculture in each country and in particular documents the variety of agricultural systems, the development of irrigation and drainage, various users and potential conflicts and the impact of agriculture on water resources and soils. Section 2 describes the organisation of water management and water use in agriculture, their institutional and economic characteristics. It also introduces the irrigation performance and evaluates water use efficiency, as well as the impact of past and current agricultural policies and of other relevant policies on agricultural water use. Both the national cases studies (this Chapter) and the information contained in the horizontal topics (Chapter 4) were used as a basis for the prospective and scenario building analysis (Chapter 5).

Agricultural Water Use

Agricultural systems

Two indicators commonly used to describe the land area devoted to agriculture are the usable agricultural land (UAL) and the cultivated land (i.e. the land used for arable and permanent crops). In Italy, Spain, and Turkey, and to a lesser extent Portugal, UAL is greater than the total cultivated land for geo-climatic and socio-economic reasons. In Israel and Egypt, almost all of the UAL is cropped. The evolution of the UAL between 1985 and 2000 shows a marked difference between Egypt, Israel and Turkey, where UAL is increasing, and the others, where UAL is decreasing, being lost mainly to urban development. In many Mediterranean countries, the cropping intensity (crops per year) is close to 1.00 although where crops pass through their entire life cycle in less than half the growing season, there may be scope for making better use of installed irrigation capacity by increasing the intensity.

Egypt's most remarkable feature is the concentration of its entire population and nearly all its agricultural lands on only 3% of the total land area. In Egypt, the most critical factors affecting its development are the availability of water and land, resulting in a tension between agriculture and urban development. Nearly all cultivated lands are irrigated (93%) as the country basically consists of a single irrigation system formed by the river Nile where all the runoff and drainage from irrigation is re-used downstream.

Annual population trend is such (annual growth rate of 2%) that the country depends on other countries for food (Egypt is a net importer of all food products except rice). Cropping intensity in Egypt is unusually high (1.89) as more than one crop (and sometimes as many as three) is taken from each year.

The Old Lands of the Nile Valley radically differ from the New Lands of the reclaimed desert areas. In the Old Lands, irrigation water is transferred continuously from the main canal system into secondary canals by combined gravity and water lifting systems. The fields are irrigated by surface methods in rotation using water pumped from side branches. In the New Lands, water is pumped under pressure from the main canal to the fields. In these areas, the more efficient sprinkler or drip irrigation systems are mandatory by law.

In Egypt, land ownership patterns directly shape the farm size distribution. The large number of very small holdings add up to a very large proportion of the total irrigated land. However, a few large agri-business holdings on the New Lands occupy a significant proportion of the irrigated land. The 1992 law abolishing the earlier agrarian reforms is directly impacting on land ownership patterns and holding size in Egypt by increasing the area of privately owned land and substantially increasing rents.

Box 1. Agriculture system in Egypt

Trends of the ratio of rainfed (found by subtracting irrigated area from cultivated land) to irrigated area are difficult to determine accurately. This ratio can be misleading since it changes rapidly when either component is small compared with the other. A better indicator is the ratio of irrigated land to cultivated area (or total of rainfed and irrigated land). In all the countries, except Israel and Egypt, rainfed agriculture is practised on at least three-quarters of the cultivated land, although yields are usually rather less than those from irrigation. Thus, the percentage of cultivated land actually irrigated is highest where climatic conditions severely restrict the possibilities of rainfed agriculture. In Italy, Spain, Portugal and Turkey, 15-20% of the total cultivated land is irrigated, while in Israel, half of the cultivated lands are irrigated (56%) and in Egypt nearly all cultivated lands are irrigated (93%). The figures for the first four countries are strongly influenced by the proportion of the cultivated land in areas where yields are adequate without irrigation.

Population trends and employment generated by agriculture differ markedly between countries of North Western side of the Mediterranean (population growth rate of virtually zero) and those of Egypt and Turkey (annual population growth rate of 1.5 to 2%). Israel is different since population growth rate is mainly due to immigration. The lowest percentage of employment by agriculture is found in Israel (2%) followed by Italy, Spain (6%) and Portugal (11%). All four countries are different from Egypt and Turkey (32% and 43%) where this percentage is higher. However, in all countries, percentage of employment generated by agriculture is steadily decreasing.

Irrigation and drainage development

An interesting feature found in the countries examined is that not all area equipped for irrigation is actually irrigated. In fact, this proportion ranged from 59% in Portugal to 97% in Israel. There are two opposing mechanisms for explaining why the figures are not close to 100% in all cases. In countries such as Italy and Portugal, irrigation may not be necessary in some years due to adequate rainfall. The situation may be different in Spain due to large-scale transfer of water and the concentration of irrigation schemes in areas where rainfall is always low. In Egypt, on the other hand, there may be insufficient water to satisfy all users. Almost all irrigable lands are irrigated in Spain and Israel. When cropping patterns change towards a higher proportion of irrigated crops such as vegetables or of crops that require more water there will come a point where the water supply is insufficient to match the demand.

Spate irrigation is a form of irrigation that does not rely on the development of permanent irrigation infrastructure. Mobile sprinkler systems abstracting water directly from rivers are also not considered equipped. Thus it is possible for the irrigated area to exceed the equipped area. However, it can be very difficult to ascertain the area occupied by these systems unless licences are required for abstraction. Nevertheless they tend to be included in the definition of irrigated area.

Box 2. Spate irrigation

Large differences were found between national and international sources on the amount of water used by agriculture. However, amongst the countries examined, Egypt is by far the country using the largest amount of water for agriculture.

In Egypt, 80% of the country's renewable freshwater resources (about 54 km^3 $year^{-1}$) is used for agriculture. About half this amount, (25 km^3 $year^{-1}$), is used for agriculture in Turkey, Spain, and Italy. Although in Portugal the absolute amount of water used in agriculture is low (9.3 km^3 $year^{-1}$), agriculture still accounts for 84% of the country's total recorded water use, and abstraction from private wells is considered to be under-recorded. The relatively small amount of water used for agriculture in Israel (1.2 km^3 $year^{-1}$, about 50% of the country's water resources) is directly linked to the nature of Israeli water policies and water saving technologies.

Box 3. Water used for agriculture

The efficiency of the use of water (the water needs per hectare) differs greatly with the type of irrigation system employed (surface, sprinkler, micro, i.e. drip or trickle, sub-irrigation and hybrid systems). These differ greatly in their cost, labour profile and skill requirements, as well as their suitability for each situation (crop and soil characteristics, field size and slope). The evolution of the methods used in the countries examined reflects factors such as: tradition, hydro-geography of the country, size of the farms, and costs associated with systems requiring water to be delivered at high pressure.

Overall, surface methods still prevail in the traditional Mediterranean agriculture in Spain (65%), Italy (73%) and Portugal (77%), and to an even greater extent in Egypt (93%), and Turkey (94%), while sprinklers and micro-irrigation are used mainly in greenhouses (Spain) and for woody crops (Italy). Although national agriculture policies in most of the countries examined tend to promote sprinkler and micro-irrigation methods in order to replace or complement surface irrigation schemes, a radical change in irrigation methods is not foreseen except locally (e.g., New Lands in Egypt, Great Anatolian Project in Turkey).

Box 4. Irrigation methods

In sharp contrast to Egypt and Turkey, surface irrigation is almost completely absent from Israel's advanced agriculture. Water conservation has been pursued by a wide scale adoption of low volume irrigation systems like drip and micro-sprinklers, and by the use of portable sprinkler lines for crops where these are not appropriate. These measures have substantially increased the efficiency of water use. However, in areas of similar climate and soil in the Gaza Strip and the West Bank, Palestinian agriculture is mostly based on furrow irrigation (Trottier, 1999), emphasising the importance of socio-economic factors. In Israel, 46% of the cultivated area is irrigated. Farms can be owned and operated either privately (moshavim) or by communal voluntary associations (kibbutzim). The latter are large and thus accentuate the weight of large holdings. Water scarcity triggered the development of efficient conveyance and irrigation system, while alternative sources are being investigated and used. Reuse of treated effluents is mainly used in agriculture, while desalination systems are promoted for the supply of domestic needs.

Box 5. Agriculture system in Israel

The average size of a holding (a farm or a part of a farm cultivated by an individual who is not necessarily its owner) is inextricably linked to issues of land ownership and the socio-economic situation of each country. A large holding in one country might be considered small in another while the size also depends on the crops grown. In all the countries except for Egypt, distributions are skewed toward the larger holdings (the average size of holding for each size class was calculated by dividing the total area assigned to the class by the number of holdings in the class). Although few in number, large holdings occupy more than half of the total irrigated area. It should be easier for water conservation policies to have an impact where most irrigation water is used on large holdings.

All the countries, except Israel draw water for agriculture mainly from surface sources, although this can be transported long distance as in Spain. Groundwater is the main source of agricultural water (54%) in Israel. Wastewater re-use[4] makes a significant contribution in Egypt and Israel and despite the lack of its promotion at the national level, an increase in the use of wastewater in agriculture is expected in both countries. In the other countries, wastewater re-use is of only local importance. The high costs of desalination limit its use to the tourism sector, especially in the coastal zones (eg. Eilat in Israel, the Red Sea resorts in Egypt).

Box 6. Agricultural water consumption by water sources

[4] In Israel, the treatment level is the most important factor in waste water reuse. Its massive reuse determines secondary and tertiary treatment levels in order to decrease potential environmental hazards.

It is difficult to find and interpret data on crop output per unit of water applied since the amount of water used depends on the crop, the weather conditions, the method of irrigation used and the effectiveness of management. In most cases, the amount of water applied to each crop is not measured on farms. Moreover, comparisons between crops are complicated by the difference in water content between grain, fruit and vegetables. However, the yield of vegetable crops per unit of applied water in Israel is approximately double that in Egypt where the climate is similar. This is due to widespread adoption of more efficient irrigation systems in Israel. The main crops irrigated in a country depend on tradition and on the degree of integration in the global market economy.

The most important crops vary between countries and over time. In Egypt, the Old Lands grow a wide range of crops, while the New Lands concentrate on higher value crops, vegetables and orchards. In Israel, most vegetable crops and orchards (exceptionally olives) are irrigated. In Italy, grain maize and rotational forage crops have occupied the largest irrigated area during the past few decades. Vegetables, vines and fruit trees are also important irrigated crops. Almost half of the irrigated land in Spain is devoted to growing cereals, sunflower, fodder crops and maize. Fruits and vegetables are intensively cultivated on another third of the land under irrigation (mainly in traditional irrigated areas of the Mediterranean coastal areas and the main inland river basins). In the Southern areas of Spain, olive trees are increasingly grown under irrigation. In Turkey, cotton, sugar beet and cereals (including rice) are the main irrigated crops. Although vegetables, fruit trees and vines are also important crops, they are not irrigated unlike the situation in the other countries.

Box 7. Major crops and use of water

The role played by irrigation in the economic development of Mediterranean countries is linked to the debate about food self-sufficiency and food security. Although food self-sufficiency, defined as the ratio of production to consumption, is beyond the reach of Egypt and Israel, food security is attainable. Spain, Portugal and Turkey are more or less self-sufficient in agricultural produce thought the latter has a rice deficit.

Historical developments in irrigation technology and the availability of irrigation water are the key factors that have shaped the present status of irrigation in each country. No substantial new development of irrigated areas is foreseen in Spain, Italy and Israel. Spain experienced a period of remarkable expansion of irrigation between 1950 and 1980, which doubled the total irrigated area in less than 30 years. As in Italy, there were large capital investments in dam building (Postel, 1999). However, the development of publicly funded new irrigation schemes has sharply decreased since Spain joined the EC. Constraints from the EU and WTO due to market liberalisation have acted to restrain the traditional irrigation expansionism in Spain. The slowdown in the rate of expansion of irrigation in Italy and Spain is also related to the higher costs of adding irrigation capacity since the best sites have already been developed, and to the growing public concern about environmental issues. This phenomenon seems to be world-wide. Overall growth of irrigated agriculture fell from 5% per year, in the decade 1965 to 1974, to 1.5% per year in the following decade (Carruthers, 1988; Orstom, 1992) and this trend has continued.

Curiously, in Portugal, which would be expected to be subject to the same pressures as Spain and Italy the irrigated area seems to be declining although the government believes that an extension of irrigated agriculture is the only means to achieve a competitive agriculture. An additional 2000 km2 of irrigated land are planned by 2006, therefore, the area of irrigated land is expected to increase by 25% in the short term. Most of this is due to the Guadiana scheme. Large-scale projects are also underway in Egypt (expansion plans for irrigated area by another 1.2 million hectares by 2017 using the Nile and treated wastewater) and in Turkey (dam building plans such as the South East Anatolian Project to increase the irrigated area by an extra 7.1 million hectares).

Box 8. Expansion of irrigated land

Different water users, potential conflicts

Competition for water resources occurs between the agricultural and the other sectors in all six countries. However, they are generally localised in space or time. In Italy for instance, there are often conflicting situations in the summer months when both agricultural and tourism sectors need large quantities of water. This is particularly true in the coastal areas where water is scarce and of poor quality due to the salinisation of coastal aquifers. A variety of indicators is used to determine and foresee the occurrence of such conflicts over the water resources, hence giving an indication of water scarcity (extensive work has been done by Falkenmark (e.g., Falkenmark 1990) since the 1960s on determining the occurrences of water scarcity in the world. For a discussion on water scarcity, see Kroll 1999).

The water balance calculated either overall or on a sectoral basis (agriculture, domestic, industrial) indicates the difference between supply and demand. The supply comes from surface and groundwater as well as desalination and wastewater re-use. The difference between the supply and demand is small for both Israel and Egypt suggesting that nearly all the water resources are exploited in these countries. Note, however, that demand can sustainably exceed availability when water is re-used. Calculating the balance is usually difficult since not all the data required are available. In particular there can be large differences between flow formed in the country and the total flow available when water crosses national boundaries.

Per capita water availability (the total water resources of each country divided by the total population) is the most commonly used indicator of overall water scarcity. The total water resources are taken to be the natural conventional renewable resources and to exclude re-used water or water obtained by desalination. The data suggest that Portugal has the highest annual volume of water per capita (7000 m^3), while Israel has the lowest (355 m^3) with the other four countries lying between 3200 m^3 and 1100 m^3. As expected, water scarcity is most acute in Israel and Egypt, while the other countries appear relatively water rich. However, overall figures for Spain, Italy and Turkey hide large regional differences. In some regions, scarcity of water is almost as acute as in Israel. Thus this indicator is only really of use at a regional scale.

A related index is the per capita water demand. It is obtained by dividing the water withdrawals, including exploitation of non-renewable sources (fossil water) and non-conventional sources (desalination and wastewater re-use), for all sectors (agriculture, industrial, domestic) by the total population. The highest annual per capita water demand is found in Portugal (1133 m^3) and the lowest in Israel (331 m^3).

The water exploitation index (the total water withdrawals of conventional resources divided by the total water resources[5]) for Egypt was around 70% in 1990 and is expected to reach 100% shortly. At that stage all conventional renewable resources will be fully exploited. Israel is also very near the full use of all available water (94%). In Turkey (31%), Italy (27%), Portugal (15%), and Spain (19%) the values are much lower.

Box 9. Water exploitation index

Only rough estimates are available of water withdrawals by sector. However, it is clear that agriculture remains the major user of water in all six countries. Proportional consumption of water is highest in Italy (18%), where it exceeds domestic consumption, and in Egypt. The highest demand for domestic water was recorded for Israel (30%).

Water used for irrigation is expected to decrease slightly in the three EU countries as a result of: 1) increased competition with the domestic and industrial sectors, 2) a predicted overall decrease in water resources, and 3) improved distribution and irrigation efficiency. In Spain, industry is expected to increase its water consumption by 25% by 2020 while domestic demand is expected to increase by 35% over the same period. As agricultural consumption is forecast to increase by 27% the relative proportions are forecast to hardly change. In the other countries, the allocation of water to irrigation is expected to become stable (Israel and Turkey), or increase (Egypt). In Egypt, the water used for irrigation increased by 80% between 1980 and 2000 but there is increasing pressure on water resources by both the industrial and domestic sectors.

Box 10. Trends in water use for irrigation

Impact of agriculture on water resources

For thousands of years, agriculture has shaped the Mediterranean landscape. However, it is only in the past thirty years that agricultural practices have radically changed in scale and in intensity of input use. The agricultural success of large irrigation schemes based on heavy investment in infrastructure such as dams and distribution networks is predicated on an intensification of agriculture, which usually involves the increased use of agro-chemicals and of high water-demanding crops. With appropriate management, pollution from agriculture can be kept to low levels but often these changes have led to adverse effects on the environment through pollution of rivers and contamination of groundwater. Of greater impact has been the destruction of fragile ecosystems such as Mediterranean wetlands and riparian ecosystems by drainage or by abstraction of water for agriculture.

The relationships between irrigation techniques and water and soil salinity have been well documented. Direct evaporation of water from the soil surface can cause an accumulation of salt in the surface layers of the soil. Irrigation water normally contains salts at too low a concentration to inhibit crop growth. However, irrigation in a climate characterised by high rates of evaporation and low rainfall can lead to soils becoming saline and unproductive unless there is adequate

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[5] Total water resources are considered here as natural conventional renewable resources

provision for leaching the salts. Water storage in reservoirs where evaporation is intense tends to increase the salt concentration of the stored water. Although the causes of increased salinity of soils and water can be identified, the impact of the degradation is less easy to quantify. Salinity problems due to the soil, irrigation water or aquifer have to be distinguished. Farmers can grow their crops providing salinity of the soil and irrigation water is below a threshold value (the worst cases of salinised soils being sodic soils and where salinisation and capillary phenomenon occur when a high salinity content aquifer is close to the soil surface). Drainage in combination with appropriate irrigation scheduling allows excess salts to be leached from the plant root zone. However, leaching programmes are difficult to implement as there is often insufficient water to cover both the crop and leaching requirements (as in Egypt).

Although the trend in the total area of salinised irrigation lands in the Mediterranean countries is unclear, it is known that there are salinity problems in Greece and in some Northern African countries. These are often linked to marine salt water incursions into coastal aquifers. Since the irrigation expansion period (1979-1989), the loss of productive lands due to salinisation has been significantly increasing worldwide according to some authors (a study from the World Bank has estimated that salinity reduces yields of major crops by 30%, Barghouti and Le Moigne, 1991, Postel 1999). As irrigation water in arid and semi-arid areas typically has salt concentrations of 200-500 ppm, applying 10,000 m^3 of water annually per ha, a typical irrigation rate, would add between 2-5 tonnes of salts to the soil each year (Kovda, 1983).

Data on salinisation at national level are hard to find. Nor are there commonly agreed methods for assessing the extent of irrigation-induced salinisation. In Egypt where salinisation data at is available, two-thirds of all the irrigated land are considered to be salinised. However, some salinised lands are still cultivated (proportion unknown). In order to decrease the problem, underground drainage is being developed and crops such as rice are being promoted.

Box 11. Irrigation-induced salinisation of lands

Overexploitation of aquifers is quantified by comparing the actual rate of abstraction with the recharge rate (the aquifer safe yield). In Egypt for instance, water is pumped from renewable aquifers and to a less extent from non-renewable fossil aquifers in the desert. Overexploitation of groundwater not only leads to a lowering of the water table but in coastal areas can lead to the deterioration of groundwater quality due to sea water intrusion and/or diffusion of salts.

In Spain, the overexploitation of aquifers is subject to debate since some hydrogeologists challenge most of the official data. Overall, official data estimate the overexploitation of underground water to be 13% of the total amount of underground water pumped each year and about 2% of total water used. Aquifers "officially" declared as overexploited cover 13 km^2 (around 40% of the total amount of water taken from them each year). Extensive work on overexploitation of groundwater in Spain has been done (e.g., Llamas, Custodio).

Box 12. Overexploitation of aquifers in Spain

In irrigated areas, the loss of biodiversity is closely linked to wetland losses. Major threats to wetlands from irrigated agriculture, particularly intensive irrigated agriculture include drainage, construction of upstream dams, extraction of groundwater and pollution. Although the causes of biodiversity loss in irrigated areas has been well documented, no comprehensive survey of the rate of loss of biodiversity appears to have been carried out at a national or regional level. Governmental agencies are usually only poorly aware of the issue and only report on it when pressured through public environmental perception, reporting and implementation obligations of international conventions and European environmental legislation. However, indices of biodiversity should exist at a country level, especially for those countries that are signatories to international conventions (e.g., Convention on Wetlands Ramsar, 1971 and the Barcelona Convention).

Although the study of wetland loss is a key component in evaluating the impact of agriculture on water resources and habitats, this information is usually incomplete or missing. Institutions responsible for nature conservation management often have poor contact with the ones responsible for water and agriculture (this is supported by the lack of a Europe wide survey of Mediterranean Member States despite the many EU initiatives in this area such as Med Wet (CEC 1995). Even the most comprehensive sources contain few quantitative evaluations of wetland loss despite the number of studies mentioning the disappearance of such ecosystems in Mediterranean regions (e.g., Finlayson et al. 1992, Pearce and Crivelli 1994). Figures for the rate of wetland loss at a national level are almost non existent, and therefore there are none for the Mediterranean countries as a whole. However, this survey shows that the status of wetlands in the Mediterranean regions has been one of continuous and rapid loss. Most countries lost 60% of their wetlands during the 20th century. This loss is not only directly linked to drainage for agriculture, but also to industrial, urban and tourist developments, or degradation through domestic, agricultural, or industrial pollution. Research carried out at basin level should focus on the direct impact of agricultural water use on biodiversity and wetlands.

International environmental conventions with a specific focus on the Mediterranean include the Convention on Wetlands (Ramsar, 1971) and the Barcelona Convention. The Ramsar Convention promotes the conservation of wetlands and assists the Contracting Parties with the management of designated sites and the establishment of national policies for wise use of wetlands (Ramsar Framework, 1997-2002 Strategic Plan). The Ramsar Convention has close links with the Mediterranean Action Plan (MAP), Barcelona Convention, and the Convention on Biological Diversity. At a European level, the wise use and conservation of wetlands are the subject of a Communication (COM (95) 189 final of 29/5/1995). The EC also finances and participates in a number of joint initiatives for the conservation of Mediterranean wetlands (e.g., MedWed Action combining the efforts of wetland conservation in the Mediterranean region with the collboartion of Spain, France, Greece, Italy, and Portugal, the Ramsar Bureau, the European Commission, and three NGOs).

Box 13. Conservation of Mediterranean wetlands

Pesticides (insecticides, fungicides and herbicides) control a variety of living organisms (vertebrates, nematodes, molluscs, acarians). Although, the scientific literature has documented the rage of use and impact on the environment and public health, a general survey of their use in the Mediterranean countries could not be found. However, market data are to some extent available. In Italy, the trend in total pesticide use shows a decrease from the peak in 1988, with no remarkable variation among the different classes. This decrease is likely to continue because of 1) the trend for cultivated land to decrease, 2) increasing awareness of the need to reduce pesticide use and 3) more effective formulations and means of their application. Some provisions in EU legislation exist concerning use of pesticides (Reg. 2078/92 on the promotion of environmentally sound agricultural production methods and Reg. 2092/91 on organic farming). However, residual contamination due to pesticide loads will remain in the food chain. In Egypt, pesticides have been heavily used with a peak in use in 1986 and a slight decrease as from 1992. This indicator is difficult to interpret without additional information since the impact of pesticide application strongly depends on the concentration, nature and mode of application of the pesticide active component.

Only Italy and Egypt provided figures for fertiliser use. In Italy, the figures for mineral fertiliser show a nearly stable situation for nitrogen, a slight increase for phosphorus, and a decrease for potassium. However, the trends differ at a regional scale.

Institutional and economic aspects of the organisation of water management and water use

Organisation of water management and water use in agriculture: Institutional and socio-economic aspects

The fragmentation of the institutional framework and the complexity of co-ordination mechanisms are two major characteristics of water management institutions in the Mediterranean countries. Several institutions often deal with the water sector and this generates plurality in policy-making and implementation. The restructuring of institutions responsible for water management is an on-going process that mainly concerns the central government and local entities. A distinction has to be made between EU countries (Italy, Portugal, Spain) and Middle-East and Northern African countries (MENA, in the present case Egypt, Israel and Turkey). EU countries are seeking a better institutional framework through processes such as “deconcentration”, decentralisation and management at the river basin level. In a decentralised system, water management is organised in four levels (central, regional, sub-regional and /or basin authorities and Water Users’ Association, WUA). The implementation of these levels in the three EU countries has been delayed due to political, administrative and financial concerns. The implementation of the newly adopted European Water Framework Directive (WFD) specifying the elaboration by Member States of comprehensive river basin management plans is expected to rationalise this process.

In the MENA countries, the institutional structure is highly centralised. Nevertheless, deconcentration of the central agencies and decentralised management of the operation and maintenance of irrigation structures have been emerging issues in those countries. Ministries in charge of water management have branches so as to represent the central government at regional or province level. At the central level, the Ministry of Environment has been gaining importance since the 1990’s and took over the responsibility of water management policies (Spain and

Portugal). In other countries, ministries mainly in charge of large investment (ministries of agriculture, public works or energy) are responsible for water resources management.

In the EU countries of the project, the WUAs have a very long tradition in water management. For many years, irrigators have constituted associations and have managed irrigation systems autonomously. Despite their undefined legal status and their authority based on custom, the WUAs are very autonomous (Spain). The WUAs collect water tariffs, organise irrigation procedures, control the application of rules, establish sanctions and deal with the operation and maintenance of the irrigation systems.

In the MENA countries, the establishment of the WUAs is rather recent in general, dating from the mid-1990's. In Egypt, water delivery is still centralised in different regions, as well as operation and maintenance of canals and control structures. The success of the "participatory management" through the WUAs is justified with a better performance base on an appropriate management reflecting a more realistic operation and maintenance costs, with a fairer approach free of any political interventions.

Box 14. Water Users' Associations in the EU and MENA countries

Traditionally, water is defined as a shared public resource. Water allocation policy among sectors is managed by the central government in charge of issuing licences for water use directly or through regional directorates varying from one country to another. In EU Member States, the objectives and criteria related to water quality management and national regulations are modified according to the EU Directives (in particular to the WFD). The basic principles are 1) polluter pays, 2) user pays and 3) cost recovery of operation and maintenance. These principles are also being introduced into national regulations in the MENA countries. However, their implementation is under debate in most of them. Agricultural and industrial pollution in receiving water and drainage canals is still a major concern.

In Mediterranean countries, hydraulic infrastructures and water use in agriculture are (in most cases) fully subsidised by the States and/or by major donors. In public irrigation systems, the tendency is to consider that the price of water should be subsidised as part of the central government intervention. In most countries, and in particular in the MENA, no charge is applied for water withdrawal. Irrigation water use is not priced and the right of use is associated with land ownership. WUAs apply a fee for the operation and maintenance of the irrigation systems that are under their responsibility. This fee does not cover the full cost in most cases (in Spain, the tariff paid by irrigators is ten times less that its real production cost).

Water charge policy for irrigation varies considerably, between countries and regions. In Israel, water allocation practices are based on allocation preferences to different consumer groups. Israel has led extensive research and technical investments in irrigation efficiency (value and crop per drop). Irrigation water charges are based on irrigated area and not as a function of the volume of water actually used as it is easier for administrations to manage irrigation water per irrigated surface. This approach results in a lack of encouragement for water saving since no extra charge is paid for excess. In EU countries, the trend is to change the charging system by installing water meters. However, it is costly to install on all irrigated land.

Box 15. Water charge policy for irrigation

In Mediterranean countries, the existing water policy for irrigation is based on subsidies and users have little or no incentives to decrease the demand (except in Israel where the use of second quality water is promoted). In practice, high priority is given by responsible authorities to increasing water supply through new projects, while financial resources remain limited for the implementation of techniques that consume less water and rehabilitation projects. Overall, in the countries examined except Israel, at least 60% of the water conveyed through surface irrigation network never reaches the crops.

Therefore, in MENA countries, enhancing supply to permit agricultural expansion driven by food self-sufficiency concerns has been the major water management approach. At present, the drastic depletion of water resources confirmed by various performance indicators reveals that demand management must be the guiding principle. In EU countries, decentralisation and river basin management are the preferred options, but their application seems to be a long-lasting process. This mutation process that is encountered in the Mediterranean points out the need of introducing better management, encompassing institutional and economic aspects, to agricultural water use, the main consumer in the region.

Present irrigation performance: efficiency of water use

Evaluating irrigation performance and water use efficiency (WUE) cannot be done through one unique index. It has to consider a variety of components related to technical and technological, economic, social and environmental criteria. The technical efficiency assumes minimum losses in conveyance systems. The economic efficiency focuses on the maximum economic value of irrigation water and the cost/benefit balance. The social efficiency is estimated by the impact of irrigation on WUE, employment, land planning development and quality of social services offered. Environmental efficiency could be related to the groundwater pollution and also estimated as the use of the marginal water sources.

Israel's agriculture experienced a radical shift in replacing the traditional surface application methods by sprinkler (mainly portable sprinkler lines) and micro-irrigation technologies. This technological shift is reflected by a significant increase in the proportion of irrigated area to total cultivated lands from 15% to 49%, that is more than five times in the last 40 years. Although, there has been an increase in volume of water used for agriculture (from 0.400 to 1.840 km^3 per year), there has been a drastic decrease in water application per unit of irrigated area from 8530 m^3 /ha since 1949 to 5780 m^3/ha in 1989. Water use decrease was accompanied by an increase in agricultural efficiency (irrigation water use efficiency rose from 1.60 kg/ m^3 in 1949 to 2.32 kg/ m^3 in 1989) and in technological efficiency, which has been maximised (estimated by transpiration as proportion of water applied).

Box 16. Technical efficiency of water use in Israel

Discussions on the economic efficiency associated with irrigation shifted from the added value of water per cubic meter or in terms of the foreign currency earned per unit volume of water applied, to the current debate on water pricing and its associated "real" price. The assumption behind this debate is that water resource is no longer a public resource. The debate stems from the fact that the agriculture sector is the single one sector using the largest quantity of water without actually paying for it. Some authors argue that most of the extensive inland irrigation practices would be inefficient in economic terms if the irrigators had to pay the cost of the dams and water distribution networks. In general, water prices only play an incentive role for using less water when irrigation schemes are billed for water according to the volumes of water consumed and not to the area irrigated (Spain, Portugal).

Intimate links exist between the technical efficiency and the social setting of irrigation systems, through irrigation application rates and timing in water-scarce regions of the Mediterranean. In Egypt, irrigation authorities know that allowing farmers to schedule their irrigation time among themselves improves the productivity of all farmers since it relies on ancient social bonds within farmers' communities. These are examples of what Orstom (1992) has called the need for "crafting" institutions, involving users and suppliers of an irrigation system throughout the design process. Understanding the rules governing how water users interact among themselves and with irrigation managers is essential otherwise both suppliers and customers receive the "perverse incentives" (quoting Orstom in her work on self-governing irrigation systems, 1992) to escape inflexible regulations, seeking personal advantage, thereby decreasing share for other users.

The social impact is very strong in some Mediterranean countries (Spain and Portugal) where large-scale irrigation schemes are perceived by authorities as a means of regional development (irrigated agriculture is usually six times more labour intensive that rainfed). However, a number of regional studies provide evidence that the transformation of lands into irrigated areas does not necessarily increase employment (Spain). Agriculture, and in particular irrigation, is also attached to the strategic intents of some states (Israel).

Incentives for increasing environmental efficiency seem to be rare in the countries examined. This partly reflects the lack of accurate indicators for quantifying the environmental impact of irrigation.

Impact of past and current agricultural policies on agricultural water use

The agricultural policies of EU and MENA countries are clearly different. While EU countries have to fit into the framework of the Common Agriculture Policy (CAP), MENA countries are not subject to a single, uniform agricultural policy. MENA countries are typically more concerned by objectives of food-security and food self-sufficiency and the associated increase in agricultural production, while EU countries are subject to opposed forces, one driven by agricultural production and the other by diminishing agricultural surpluses. To achieve objectives of food-security, various strategies are used, ranging from price subsidies (Israel where subsidised water price is part of the country's settlement policy), allocation of funds by the state to finance hydro-agricultural projects (Turkey) or through the shift to a more competitive and market driven approach. EU countries on the other hand faced the same context at the onset of the CAP. Today, the context has evolved and agriculture in Europe has mainly one economic issue: agricultural emigration. In European Mediterranean regions, highly productive agriculture is only possible with water resources at hand. This has shaped the state policies and investments in hydro-agricultural infrastructures to the benefit of irrigation. However, countries like Spain which have intensively developed irrigated agriculture now face higher costs for bringing water from increasingly distant sources. This is in favour of a marked decrease in irrigated expansion.

Agricultural policy is gradually shifting towards rural development policies aimed at diversifying activities in rural areas as a way to recognise the multifunctional role of agriculture. A common trend among all national agriculture policies emerges. It implies either increasing the total irrigated surface (MENA), or using water more efficiently on the existing irrigated areas (EU countries). This trend is linked to recent agreements of international agricultural trade, in the EU and more chaotically in WTO arenas, tending to liberalise agriculture trade. However, recent large scale protests by agricultural organisations and citizens associations is quite illustrative of the need perceived to redefine the very nature, means and objectives of agriculture in European and worldwide, hence the use of water resources.

Agricultural policies directly influence the use of water resources through two main policy levels: 1) the agri-environmental measures and 2) the common market organisation as direct support per irrigated hectare. The relationships between the objectives of agri-environmental measures and the use of water in agriculture are part of the new CAP reform. The objectives of the CAP are to ensure reasonable prices for European consumers and fair incomes for farmers (common agricultural market, single prices, financial solidarity and Community preference). The CAP has been allocated almost half of total Community budget.

The perspective of the enlargement triggered a reform of the CAP (adopted in 1999 for the period 2000-2006). It emphasised food safety, environmental objectives and sustainable agriculture. One of the five aims of the new CAP reform (an integral part of Agenda 2000) is to introduce a strong rural development policy.

The agri-environment programmes set out offer payments to farmers who, on a voluntary and contractual basis provide “environmental services” to protect the environment and “maintain the countryside”. The payments are based on the costs incurred by the farmer who carries out environmental activity. These payments would only be made for measures which go beyond the application of good agricultural practices, providing the farmer already respects minimum environmental requirements set out by national and EU legislation.

Box 17. Agri-environmental measures of the reformed CAP (2000-2006)

To evaluate the degree of implementation of such policy, agri-environmental indicators are necessary. First attempts have been made in that direction (British Ministry of Agriculture, Fisheries and Food, 2000). Future users of these indicators are those in charge of implementation and of decision-making at national and EC levels. Despite these efforts, there is no uniform definition for “good practices” in Europe up to now and the conceptual basis of paying farmers for services to the environment is not clearly defined.

Impact of other relevant policies on agricultural water use: Regional development, land use planning, tourism and industry

The impact of policies other than strictly water and agriculture policy includes regional development (national and major donor policies for non EU Member States), land use planning, other economic sectors (tourism, industry) and environmental policies (water policies, biodiversity, habitat protection). In EU countries, where the situation is much easier to delineate since Community legislation is the rule, three main external driving forces may influence agricultural water use: 1) the new Water Framework Directive (WFD), 2) the new orientations of the CAP under Agenda 2000 and 3) the regional /national policies enforced in EU Objective 1 regions supported by the structural and cohesion funds.

The new European water policy

Formal and established functional links between agricultural and water policies (the WFD, the CAP and its reform under Agenda 2000) have not been laid down up to now[6]. Water quantity objectives, which could directly affect agricultural policies are not within the scope of the WFD, which is left to the discretion of the Member States. A new system of complex water quality definitions has been set up in the WFD to replace the water quality data requirements previously mandatory in the “old” water Directives to be repealed under the new WFD. However, the main asset of the WFD is the promotion of water management according to river basins. The WFD also aims at prevent further deterioration, protect and enhance the status of aquatic ecosystems and promote sustainable water consumption.

In practice, the general requirements for defining water quality will be subject to flexibility, leaving Member States to adopt a definition adapted to their geo-climatic and economic particularities. The definition of “good quality” relevant for drawing up programmes of measures will be based on requirements formulated in the Annex of the Directive. These requirements are mainly based on the significance of the impact of human activities on the environment. It is most likely that resulting requirements concerning concentrations of certain substances (nitrates, phosphorus and pesticides) in the waters will differ between the various river basins. This will certainly lead to a heterogeneous picture of environmental requirements and influence the adoption of basic water pollution limit values by the various agriculture, industry and domestic sectors.

Requirements concerning water pricing are not found in the WFD and are subject to a non-binding Communication As mentioned earlier, pricing water would definitely have an impact on the share of water resources amongst users. This would have an impact on agricultural costs, especially in the Mediterranean regions where irrigation is paramount. In the WFD, the emphasis is still on water quality as it is not expected to refer directly to water quantity requirements. Therefore, water quantity objectives will remain the responsibility of Member States, mainly through their agricultural policies.

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[6] Project WADI, http://www.jrc.es

Land use planning

All three EU countries examined contain EU Objective 1 regions. The elaboration of Regional Development Plans (RDP) in each country includes specific measures for hydraulic works and treatment plants. One of the priorities taken into consideration for the elaboration of the inter-sectoral plans is the co-ordination between policies related to agriculture, environment, research and public health. Although it is unclear at this stage how to best quantify the impact of these policies on agricultural water use, all focus countries have noted that regional development policies can both hinder or favour water use efficiency in agriculture. Rural development policies aiming at promoting cost-effective agriculture seek the modernisation of farms. This, in principle should lead to the adoption of efficient water saving technologies, but in practice, the label “regional development” is often used by local authorities to encourage a policy of “rural population maintenance”, supporting and maintaining traditional, and preventing the rural emigration and depopulation (Spain and Portugal). The areas designated as "Less Favoured Areas" are eligible for specific measures and compensatory payments to counteract the rural depopulation. The compensatory payments are applied, for instance in case of highly salinised soils.

Every five years, a new Regional Development Plan (RDP) is prepared and used as a basis for the investment strategies in Portugal. This Plan is also used as the basis to negotiate EU funds, especially the European Regional Development Fund (ERDF), European Social Fund (ESF), and the European Agricultural Guidance and Guarantee Fund (EAGGF Council Regulation 1257/1999). The preparation of such plans is based on the characterisation of the five planning regions of the mainland and the two autonomous regions of Madeira and Azores Islands. Agriculture policy has a direct impact on the preparation of RDP because all major investments need to be considered and integrated to regional development strategies (e.g., construction of infrastructure, professional training, storage facilities, distribution networks). Land use planning is seen today in Portugal as a means to convert agricultural lands into urban lands. This happens in the regions with low agricultural productivity and high urban development, often associated with expansion of tourism (e.g., Algarve). Since 1990, it has been mandatory for all municipalities to prepare a Municipal Master Plan which include provisions for the National Agriculture Reserve and the National Ecological Reserve. This obligation has contributed to slowing down the trend to convert rural into urban lands.

Box 18. Land use planning and agricultural water use: the Regional Development Plan in Portugal

In Israel, regional development was initiated through national goals. Transfer of water sources was operated by Mekorot, the National Water Carrier for the peripheral settlements in the North and especially in the South. Transfer of water to the South at a subsidised price enabled irrigated agriculture to be developed. Tertiary treated effluents from Dan Regional Treatment Plant (SHAFDAN) are conveyed to the South enabling agriculture.

Box 19. Land use planning and agricultural water use in Israel

Tourism

With 250 million national and international tourists annually, the Mediterranean region is the most important tourist destination in the world. Tourism increases demand for drinking water: (i.e., 500 to 800 l/day per capita in luxury hotels, far more than regional water demand). It also encourages service and leisure activities which use large quantities of water and cause an over-extension of water distribution and sanitation facilities (golf courses consume as much water per capita as well irrigated schemes, 10.000 m^3/ha/year). However, the importance of tourism for the Mediterranean countries is such that its social and economic weight, contribution to trade balances, potential of development, it has become an unavoidable stake for most countries. For some locations that are difficult to reach, such as islands, tourism appears the only activity able to counterbalance the degradation of traditional economies, by stabilising local populations, and even reversing population centrifugal migratory trends.

Overall, there is no generalised conflict between water use for irrigation and tourism, except in some regions where there is a clear case for water resource competition. Given the higher profitability of water used for tourism, this will put a pressure to improve efficiency in the agricultural sector. It will also probably favour the development of new arrangements between tourist areas and irrigation users in their surroundings (like one already established in Benidorm Spain), whereby farmers cede some of their water rights to the urbanised tourist areas, while they receive their treated effluents for irrigation.

In the near future, conflicts for water resources are expected to increase in intensity and in frequency between the tourism and agricultural sectors, especially with irrigated agriculture. Reallocation of water from agriculture may result in a great increase of water supply for other sectors. When agriculture represents 90% of national water consumption, a 5% water saving in agricultural water demand provides a 50% increase of water supply for other sectors.

Although tourism is seen to have an important economic value in Spain (around 9% of GDP), it does not represent a big water consumer *per se*. The estimated number of foreign visitors (i.e., about 60 million per year) only adds the equivalent of about 1,5 million people of permanent population, which would be less than 4% of total population (urban consumption is only around 15% of total water consumption). However, other types of impact are attached to tourism. Visitor mainly arrive during the summer season and tend to concentrate on Mediterranean coasts and archipelagos, which are precisely those in need of water for irrigation during the summer season. Tourists, whether domestic or foreign, tend to use higher amounts of water per capita than normal residents, both as the result of their “personal” consumption and operation of the facilities that they use, including swimming pools, gardens, and golf courses.

Box 20. Water used by tourism in Spain

Industry

Industry is considered to be a minor water consumer compared to agriculture. However, many industries in the Mediterranean countries use higher quantities of water compared to their needs and degrade its quality by deficient recycling and processing. In the EU countries, quality of effluents from industry is partially regulated by IPPC Directive, promoting Best Available Techniques and the Dangerous Substances Directive 76/464/EEC.

In Spain, the main source of electricity consisted of hydropower from the onset of industrialisation until the 1970s. From the 1970s, the share of electricity produced by hydroelectric dams decreased to below 50% of its value during the industrialisation period (the share of hydropower accounts now for 15-20% of the total amount of electricity produced). Tight competition has been in place for some time between hydroelectric and irrigation uses in view of the geophysical and climatic distribution of the water resources.

Dams used for hydroelectric power plants tend to be concentrated in the North of the country, while those used mainly for irrigation are found in the South. Thus, the Ebro and Duero basins of the North) contribute 80% of the production of hydroelectricity while they only consume about 25% of water used for irrigation. The conflict between hydroelectricity and irrigation is low there. In other regions, irrigators downstream from large hydroelectric power plants experience too much water being released in winter when it is not used, and less water released in the summer, when most needed. According to electric companies, the economic benefit of water used for electricity production is higher than the economic return from the irrigation sector. Nowadays, the conflict between hydroelectricity and irrigation sectors in Spain is low. These two sectors occupy different geographic locations and the use of water by industry as a whole is not high comparedy to agriculture.

It is worth mentioning that in Spain, most fossil-fuel and nuclear power plants use water for cooling purposes. However, this is usually operated in “closed circuit” with “low” intake of water from rivers. These are seen as not having a significant impact on agricultural water use

Box 21. Water use: agriculture and industry in Spain

Environmental policies (national and major donor policies)

Environmental protection related to water management in irrigated and drained areas and proper use of non-conventional water resources, has to be assured by government, agencies and users. This requires, among others, an effective monitoring and control of environmental impacts of water management. The trend in using non-conventional water resources is mainly towards the reuse of treated effluents, drainage water, and brackish or marine water. As mentioned earlier, EU legislation some of the mostly influent on the use of water in agriculture are the nitrate Directive (Council Directive 91/676/EEC), environmental impact assessment, and groundwater Directive (Council Directive 80/68/EEC).

Conclusions

The countries and issues studied

The six countries studied showed some similarities but differed in important ways, for example in terms of land ownership, control over water resources, availability of groundwater, rainfall amount and reliability, and degree of intensity of agriculture and its market orientation. Although many influences on the exploitation of water resources are external, for example treaty obligations, international agreements, trans-boundary issues and the global economy, the way in which these issues are dealt with will depend on the political and socio-economic situation in each country. To a lesser extent this is also true of data collection as some countries have a long history of centralised collection of agricultural data while others have not required this information. Although the amount and quality of available information varied considerably, it was still possible to assess the state of irrigated agriculture in each country and to identify the key issues affecting the future evolution of trends.

The key issues relating to water use in the Mediterranean countries were covered, with the exception of long term utilisation of fossil water resources, which is mainly an issue for Libya.

Overall situation

It can be misleading to talk about the overall situation in the Mediterranean countries due to the differences mentioned above. However, the sustainability of irrigated systems is becoming an issue in all countries even though the reasons for concern may vary. Irrigation systems are only sustainable if :

- water of adequate quality is available at the right time and in sufficient quantity,
- the system is profitable to the farmers,
- negative impacts on the environment are tolerable both in terms of international obligations and acceptability to other stakeholders.

In countries such as Egypt and Israel almost all the resources are used completely and any expansion depends on using water more efficiently and re-cycling wastewater. In Israel, the most efficient schemes are close to the theoretical efficiency and any progress would have to come from changing the crops grown to ones that make better use of water. In other countries, there is scope for increasing the efficiency of water use considerably. This does not necessarily mean changing the irrigation technologies, as maintenance of distribution networks, monitoring water used and training of farmers and technicians also provide opportunities to save water. A major issue is the price of water, particularly in view of the needs for water by the domestic sector and for environmental protection. This, along with other important issues was investigated during the horizontal studies.

Perhaps surprisingly, none of the groups raised the issue of climate change although any diminution of rainfall or decrease in reliability will pose a serious threat to irrigated agriculture due to its impact on water resources.

Chapter 4

4. KEY ISSUES AFFECTING AGRICULTURAL WATER USE

Introduction

In the previous phase of work various important issues emerged that were common to several Mediterranean countries and where a comparative approach was thought to be useful. All the topics proposed in the Technical Annex were covered explicitly (Table 1) except for regional infrastructure development and education and extension policies, which are covered as part of other topics or elsewhere. The identification of the topics and the partner responsible for them took into account the specific expertise and interests of each partner and the needs of the subsequent phases of the work. Only key conclusions of each topic have been highlighted in this chapter since detailed information can be found in the Scientific Annual Report 2000 (Kroll, A. Ed. 2001).

Topics	Leader
Major donor policies for Mediterranean irrigation projects	UNEP/BPRAC
EU agricultural, environmental and Regional policies	IST
Agricultural trade policies: Import/export trade policies	AERI
Relationships between government institutions and social agents	ASP
Water pricing: Water permit trading and water markets	IBU
Land Ownership patterns: Influence of property structure on efficiency of water use	IPTS
Agronomic and economic limitations	ARO in co-operation with UST

Table 3. Horizontal topics

Generic Methodology

A common structure was specified for the studies at a meeting in Sevilla to promote compatibility between them and to maximise their subsequent usefulness. The need to define each question precisely was recognised The precise methodology varied from topic to topic due to the nature of the topics, but all utilised the results of the country studies carried out by each partner and most used a questionnaire followed up where necessary by interviews. In order to ensure that the key issues had been addressed and to further improve harmonisation, the reports were all read by a small group drawn from the partners, and an executive summary was produced for each by a member of another group. The partners were given the opportunity to comment on the accuracy of the summaries. This mechanism combined elements of quality control and peer review and was an important way of ensuring rigour in the studies.

Major Donor Policies for Mediterranean irrigation projects

Introduction

International Financial Institutions (IFIs) play an important role in the development of irrigation in the Mediterranean region, particularly in the non-EU countries. They provide support as credits, soft loans or as funding e.g. for capacity building. Influences can be direct as support for irrigation infrastructure development or indirect through any conditions attached to the investment. The study was carried out by Blue Plan and considered the whole Mediterranean basin and not just the partner countries.

Objectives

The study explored the attitudes of the major donors towards irrigation and how they were likely to change in the future. Two main themes were:

- to identify trends in the policies of the major donors
- to assess the consequences of these trends for agriculture water use.

Methodology

The main part of the study consisted of analysing the annual activity reports of the three main IFIs (World Bank, European Investment Bank, Islamic Development Bank) in terms of priorities, funding allocation criteria, support for rehabilitation of inefficient systems, support for more sustainable forms of irrigation and promotion of higher water use efficiency. In addition, some assessments conducted by the World Bank and the European Investment Bank were analysed and their experts were consulted. A questionnaire was also sent to the partners.

Results

Most donors put pressure on the main Mediterranean countries to re-write operational directives for irrigation schemes and to promote cost recovery from farmers.

Instead of loan covenants that require borrowers to form irrigators' groups after the event, donors encourage the formation of more durable groups through experimentation and piloting prior to large scale funding.

In view of the environmental problems caused by drainage (which is often an important element of a sustainable irrigation scheme) donors are beginning to recognise the need to sponsor experimentation and piloting of drainage schemes to identify suitable solutions prior to large-scale extensions. The EIB has particularly taken this viewpoint.

Trends in the major donors' policy are strongly related to the implementation of Integrated Water Resources Management (IWRM) .The institutional and legal framework for IWRM is set-up in many cases. Problems emerge when the enforcement of water laws related to the control of water use, pricing or environmental protection is ineffective.

As the competition for public funds is very strong in each Mediterranean country, these approaches of the major donors may encourage national efforts to save water. Therefore the main message to be addressed to Mediterranean stakeholders could consist in warning them that the expansion of irrigated area can not be expected at the same level as in the past, not only because of physical constraints but also because of probable financial limits. Taken together these trends will ultimately result in a decrease in the water used in irrigation.

- Less money for irrigation
- More money for rehabilitation and the development of existing systems
- Wider assessment criteria
- Support for more sustainable irrigation
- More effective organisation of irrigators' groups
- Carefully piloted micro–drainage schemes are needed
- Cost recovery from farmers is increasingly important

Table 4. Trends of major donor policies in Mediterranean irrigation projects

European Union Agricultural, Environmental and Regional policies

Introduction

The Portuguese partners studied the impact of EU policies on the amount of water used in agriculture in the Mediterranean countries of the European Union. The Common Agricultural Policy has been a prime driving force shaping pressures on water in the agricultural sector within the EU. However other policies such as environmental policies are interacting with the agricultural sector, setting constraints on water use and thus progressively having impacts on water use in agriculture, which is still the most water consuming activity among the Mediterranean countries of the EU. This section identifies the direct and indirect effects of those policies on agricultural water use.

Objectives

The study aimed to describe for Italy, Portugal and Spain:

- the impact of the CAP and agriculture-related Directives on agricultural water consumption
- the ways in which EU Policies and directives were applied

Methodology

The methodological approach was based on discussion with responsible agents in the Portuguese Ministry of Agriculture who explained the decision making process of public and private agents who influence the use of water in agriculture. This experience was discussed with the Italian and Spanish partners. A questionnaire was sent to these partners covering the EU Directives that affect the way water is used in agriculture.

Results

The Common Agricultural Policy

Within the context of Common Agricultural Policy, two basic drivers were identified: price policy and investment in hydro-agricultural infrastructure. It is the price policy which determines through the allocation of subsidies the crops which are most profitable. Some crops, such as maize, based on rain-fed agriculture in northern Europe have to be irrigated in the Mediterranean countries. The change from a non-irrigated crop to an irrigated demands investment in hydro-agricultural infrastructure. Where gravity irrigation was the dominant type, the investments required were large and were only possible through government support. The development of efficient irrigation methods with lower capital costs, and the support of private ownership encouraged by EU policies has resulted in a trend towards the adoption of so-called 'SOS-irrigation' where irrigation is only used when rainfall is not enough. Thus it is becoming easier for individual farmers to change from a rain-fed to an irrigated crop in response to fluctuations in crop price. This type of irrigation makes it more difficult to control the irrigated areas, which may vary considerably from year to year.

In Portugal, the irrigated area seems to be declining although the government believes that an extension of irrigated agriculture is the only means to achieve a competitive agriculture. An additional 2 000 km2 of irrigated land are planned by 2006.

In Italy, however, since experts and authorities agree that the irrigated area should not be extended, EU funds are only used for upgrading existing structures. There are two reasons for this. Firstly, severe water scarcity, especially in the southern part, discourages farmers from cultivating irrigated crops because of a high risk of there being insufficient water in drought years. In these years domestic consumption has a higher priority for water as tourism is considered more important for regional development. Secondly, the water storage infrastructure is already close to the maximum.

In Spain, the irrigated area seems to have reached a technical maximum in terms of economically-viable use of available resources. It is expected that irrigation policy will change to encourage a more competitive agriculture through an increase in water price.

Some authors believe that the CAP has not met its original objectives because of excessive reliance on price support as a means of implementing the policy. Typically southern crops are less valued than cereals that are very productive in northern Europe and not as much in the south. In fact, most of the irrigated crops are fruits, vegetables and other high value products, which are not supported under the CAP market policy. On the other hand, water is made available at below cost price. Thus, the existence of a particular type of agriculture depends on the pricing policy. International agreements moving towards open, global markets are likely to lead to a reduction in irrigated area which, with farmers using less irrigation or employing more efficient systems, will lead to a decrease in water consumption by agriculture. The evolution of water consumption in Portugal, Italy and Spain is consistent with this trend, although official acceptance of this emerging evidence varies from country to country. On the other hand, most irrigation in southern Europe is still associated with small farms where the availability of water for irrigation is critical to viability and is therefore of crucial social importance.

The 1992 CAP reform introduced agri-environmental measures. The implementation of these and their impact on water conservation and conservation of natural ecosystems has varied considerably between countries and, in the case of Italy, between regions. In the recent (2002) mid-term review of EU farm policy Towards Sustainable Farming the European Commission has stated that public expenditure on farming must be better justified. In particular it must provide a better return in terns of preservation of the environment and landscapes. To achieve this aim the Commission proposes that payments should be contingent on meeting specified environmental standards. The definition of these standards is likely to be set by the member states allowing divergences in interpretation between countries. Successful implementation will also depend on sufficient effort going into education, information and demonstration.

Environmental Policies

EU environmental policies are becoming increasingly important in their impact on agriculture. However, the relationship between agriculture and environmental quality is complex and there is often insufficient knowledge and lack of understanding of key interactions. Moreover, these interactions may vary from location to location. The political response to the impacts of irrigation have inevitably been rather fragmented. Six separate EU directives are particularly relevant: the Nitrate Directive, the Framework Directive for Water, the Environmental Impact Assessment Directive, the Habitats Directive and the Wild Birds Directive. These have all been incorporated into the legislation of the member states. Parts of these Directives provide EU-wide standards. However, member states are responsible for identifying the boundaries of, for example, Nitrate Vulnerable Zones and Special Protection Areas, subject to EU criteria. The Water Framework Directive is rather different from the others in that it recognises the need for the setting of targets and thresholds to take account of local priorities and environmental circumstances. Although it could potentially have a large effect on water use through recovery of costs for water services, Italy considers the Directive requirements are already taken into account in its legislation and the Portuguese authorities feel it will not have a major impact.

Regional Development Policies

The impacts of Regional Development policies and the allocation of structural funds have to be addressed in the three EU countries in terms of the allocation of funds to regions. Most of Portugal, most of Spain except for the north-east, and Southern Italy have Objective 1 status. These funds have been directly used for major hydro-agricultural works and have thus contributed to an expansion of irrigated agriculture. However, other investments, such as in transport, may also affect the agricultural system used by farmers and thus water use. For example, the Vasco da Gama Bridge over the River Tagus in Portugal has brought the southern regions closer to the Lisbon markets.

- EU policies have had an important influence on water consumption in the agriculture sector of the Mediterranean EU countries
- The CAP and Regional Development funds have encouraged large scale irrigation
- EU environmental policies and external market pressures are likely to result in a reduction in irrigated area and an increase in the efficiency of water use
- There are differences between countries in the way EU legislation has been applied
- There is a lack of communication between the agricultural and environmental sectors
- Integration among policies, sectors and people is necessary for a balanced and sustainable solution

Table 8. European Union policies and agricultural water use

Agricultural Trade Policy

Introduction

The Egyptian partners carried out the horizontal study on the impact of agricultural trade policies. Agricultural trade liberalisation will affect the types of crops that can be grown profitably and thus the need for irrigation.

Objectives

The ultimate goal of this study was to assess the impact of agricultural trade regimes, particularly trade liberalisation, on the economic variables that affect water use and environmental conditions.

The following objectives were identified:

1. to explain the Common Agricultural policy of the EU before agricultural trade liberalisation and to assess its impact on water use.

2. to describe the evolution of trade between the EU and non-EU Mediterranean countries.

3. to quantify the relationship between projected and actual agricultural trade variables during a period of liberalisation of agricultural trade.

4. to quantify the relationship between agricultural trade regime and agricultural economic variables.

5. to assess the effect of trade regime on agricultural water use.

6. to evaluate the consequences of trade liberalisation on pollution by agriculture, and thus on water quality

Methodology

An extensive literature search was carried out and followed up by questionnaires to the partner countries, seminars and extensive interviews with experts. Both qualitative and quantitative analyses were carried out using, for example, regression models with dummy variables, time series analysis, and linear programming. Egypt made an appropriate case study since it has passed through periods of central planning, agrarian reform and trade liberalisation.

Results

The study objectives were largely achieved in spite of problems in gathering data on water use in the Mediterranean and EU countries. It was particularly difficult to assess the impact of trade on the environment because of a lack of data.

The global trade environment has changed substantially since the completion of the Uruguay Round negotiations. However, agricultural trade in the EU has not yet been completely liberalised. The EU has started to implement further reforms of agricultural policy but the changes proposed still impose budgetary and trade burdens. Import duties, trade barriers and other direct or indirect subsidies lead to market distortions and consequently affect water use since the crops which are subsidised or which are protected by import duties will be preferentially grown even though these crops may be high consumers of water. According to WTO regulations, there must be a system of water cost recovery particularly in those countries increasing the use of water in agriculture. Many developing countries and most of the Mediterranean countries are already adopting agricultural reform programmes, which include agricultural trade liberalisation.

At the Seattle conference of the WTO, the developing countries claimed that developed countries continued to subsidise their exports while erecting barriers to the import of produce from developing countries. For example, the amount of potatoes, cotton, and rice exported by Egypt to the EU is limited by quotas and other trade barriers. An agricultural agreement and partnership between the EU and Egypt providing for the expansion of Egyptian export quotas and the length of exporting season, as well as exemption from some tariffs has been approved (2001/C 304 E/02) although this agreement is more restrictive than the one for industrial products. The Cairns group (Australia, New Zealand Canada, Argentina, Brazil, Uruguay) supported by the USA would prefer to maximise agricultural trade liberalisation and to deal with agricultural products in the same way as industrial products. However, the EU has asked for negotiations to include issues such as competition, investment and environment.

Increasing trade has encouraged the development of private commercial operations but where water is not charged at its real cost the public can subsidise them by paying the cost of environmental degradation. In these cases, a strong regulatory system is therefore needed to protect the environment. In Egypt, for example, the Ministry of Agriculture and Land Reclamation has adopted policies for reducing pollution from agricultural sources by: rationalising the use of fertilisers; implementation of integrated pest management programs; establishment of organic and biological treatment for the production of clean and non-contaminated food; and recycling farm wastes.

The comparison of actual and projected variables in the period of trade liberalisation in Egypt showed that other factors, such as agricultural policy objectives, could affect exports and imports. In fact, for some crops earlier agricultural reforms in Egypt had a greater effect on production, cropping area, and trade. The potato area has been positively affected by trade liberalisation while the earlier reform programmes positively and significantly affected the area of rice and other crops.

The total agricultural water requirement is the result of many factors, such as changes in cropping pattern, which may result from the changes in trade and agricultural policy. In a country with no pricing for water the farmer will choose the cropping pattern that will maximise his profits regardless of the water consumed, subject to any government regulations on water usage. Agricultural trade liberalisation can affect water use through:

- development of markets for agricultural produce
- ending of guaranteed price mechanisms for agricultural products

- changes to agricultural trade infrastructure and mechanisms, i.e. logistics, facilities, freight rate, market structure, that facilitate trade.

As a consequence of these changes, more efficient use has been made of water for some crops in some regions of Egypt although there has not yet been significant change at the country level. The total amount of water used increased both in the period of agricultural reform and in the period of trade liberalisation compared with the centrally planned economy phase. Part of this increase was due to the expansion of agricultural area and part to substitution of more profitable but more water-demanding crops.

In Egypt, before agricultural reform and trade liberalisation, there was a significant upward trend in fertiliser use, whether expressed as total fertiliser use or per unit of land. After liberalisation, there was a significant downward trend. Higher prices caused by the elimination of subsidies made the farmers use fertilisers more carefully, with a consequent improvement in water quality.

• Subsidies, quotas and tariffs, which can distort water use, are still in widespread use in the Mediterranean region
• Most Mediterranean countries, with the exception of Israel, either give hidden subsidies for water used for irrigation or completely subsidise water for agriculture
• Developed countries need to address the negative effects of trade liberalisation on Mediterranean countries.
• The main agricultural exports from Mediterranean countries to the EU are fruit and vegetables, which are heavy users of water.
• Encouragement of organic agriculture in the Mediterranean countries will help to put the region in a competitive position with respect to agriculture exports as well as having environmental benefits
• The revenue per unit of applied water is an appropriate basis for optimising cropping patterns in Mediterranean agriculture
• However, there is not yet an effective way of incorporating environmental costs into policy

Table 5. Agricultural trade policy and agricultural water use

Relationships between Government Institutions and Social Agents

Introduction

The Spanish partners carried out the study on the relationships between institutions and social agents regarding water and agricultural policies. It was quite obvious from the beginning to all members of the project that among the factors to be discussed there would be a place for institutional questions. The problem of improving efficiency in the use of a natural resource like water, is complicated by the “tragedy of the commons”. Farmers and others may behave fully rationally in pursuit of their own individual interest, and yet in the long term achieve a result that is harmful to them. Although this problem has been tackled by transforming the common good into a private or a "public" (i.e. state-owned or at least state-controlled) good, there are many examples of unsustainable exploitation of a shared resource.

Objectives

The objectives of the study were to determine:

1. the types of local, regional and national institutions involved in water and agriculture in the Mediterranean countries.

2. the influence of these bodies on the effectiveness of water management by irrigators.

Methodology

The work was carried out by analysing quantitative and qualitative data from questionnaires that were sent to the project partners. The study was focused on two distinct levels, low-level institutions dealing with the administration of basic irrigation schemes, and regional and national level institutions. Institutions were evaluated against criteria that have already been shown to be characteristic of successful management of shared resources such as irrigation water. These principles are:

- clear definition of the geographical boundaries of the scheme so that everyone who benefits also contributes
- proportionality of benefits and costs
- guarantees that decisions properly reflect the interests of all concerned
- effective monitoring
- graduated sanctions
- conflict resolution mechanisms to ensure that the principles are fairly applied
- state recognition

- nesting of organisations within other organisations covering wider areas but applying the same principles.

Results

In the case of the six partner countries, the main institutions concerned with water use are either based on a central authority or on self-regulation and not on a market system since none of the countries has a well-developed system of water rights or water trading.

Low-level institutions

In all the countries, with the possible exception of Israel, self-governing institutions deal with the primary level of administration and management of irrigation networks. However, in Egypt and Turkey, some parts are administered by state bodies. This dominance of self-governing institutions is not surprising since irrigation was practiced in many of these countries long before there were any state institutions. It is probably the relatively recent development of irrigation in Israel and Turkey that explains the apparently lower level of importance of self-governing institutions in these countries. The general recognition by governments of the importance of these self-governing institutions for managing irrigation schemes can be put down to the dissemination of research findings and to the policies of international organisations such as the World Bank. In fact, governments reformed many of these bodies in the 1980s and 1990s providing state recognition and improving their effectiveness. All the institutions described in the national reports are based on an assembly in which all members can participate and that is responsible for decision making. In some cases, a president is elected by the assembly but in others the president is a government appointee. Where management is carried out by public bodies, the responsible people are neither elected by the farmers nor responsible to them and the principle of collective choice is absent. The degree of autonomy from the state varies from country to country although these institutions are generally allowed considerable freedom to modify rules for allocating water and recovering costs.

In general, self-governing bodies follow the principle of internal proportionality (a fair distribution of costs and benefits) since the system management costs are paid for by the members broadly in proportion to the benefit they gain, i.e. they contribute a fixed amount per hectare, sometimes modified by the amount of water they use. However, public bodies are often unable to implement this principle since they can find it difficult to collect the fees from farmers. No examples were found of the application of the principle of external proportionality, i.e. where the users bear the entire cost of building, operation and maintenance of an irrigation system. Self-governing bodies tend to be efficient in monitoring and enforcing water use rules and in some cases institutional mechanisms for conflict resolution have evolved outside the general justice system.

High-level institutions

Although in theory there could be a pyramid of self-governng institutions in a country, there appears to always be a clear qualitative distinction between the low-level bodies discussed above and the institutions operating at the river basin level and above which are always state institutions. In these organisations, the principle of proportionality is not observed as major water infrastructure is almost always paid for out of general taxation. An indirect effect of these subsidies is to lower the pressure to use water efficiently. Water users are often repesented in the state governing bodies, but only in an advisory capacity as the institution's main responsibility is to the country as a whole and its taxpayers. Many public bodies suffer from a severe lack of funding which compromises their ability to monitor usage and enforce decisions.

- Official markets for water are poorly developed in the Mediterranean countries
- Low-level management water organisations are usually self-governing and can be very effective
- High-level management is invariably by state institutions
- Inefficiencies in water use are encouraged by non-observance of the principle of proportionality
- Some water management systems that are considered highly successful in terms of sustainability and avoiding conflicts between users are not very efficient in terms of water consumption

Table 6. Relationships amongst different government institutions and social agents and water and agricultural policies

Water Pricing

Introduction

The Turkish partners carried out the horizontal study on water pricing policies. Water pricing is increasingly seen as an effective tool to promote more efficient allocation of scarce water resources, and conservation of water in the agricultural sector. Indeed the WTO requires there to be a system of cost recovery. It is also regarded as a means of securing the sustainability of water resources both in quality and quantity through reducing demand and providing revenues to manage the system effectively. Water pricing policies differ between the partner countries.

Objectives

The objectives of the study were to determine:

1. whether pricing reforms are likely to be adopted

2. whether such reforms are likely to be effective in achieving the objectives of water demand management

Methodology

The work was carried out by reviewing the relevant literature and by investigating the current pricing practices and policies of the partner countries.

Results

Water is increasingly becoming a scarce resource as a consequence of urban growth and changes in consumption patterns. There is also a growing awareness of the significance of water quality and the environmental costs of agricultural water use. Water pricing is one mechanism for managing water resources with a view to increasing the efficiency of water use and minimising adverse consequences. Water costs can be divided into: 1) the costs of providing and administering technical services, 2) environmental costs, and 3) resource costs incurred as a consequence of depletion. However, since agricultural water is heavily subsidised in most countries, including the partners in the PolAgWat project, implementation of the principles of "full cost-recovery" and "user-pays" necessitate serious pricing reforms in the agricultural sector. The present study has revealed two main points.

First, pricing of agricultural water must not disregard economic principles, as has traditionally been the case. Ignoring these principles will only result in the loss of welfare for the whole of society. Thus, pricing reforms must involve more than just arbitrarily increasing the cost of water and must take account of the consequences for the whole of the economy.

Secondly, there are constraints arising from the nature of land ownership and the structure of agriculture as well as political, social and cultural realities at the national and sub-national/

regional level which may hamper the adoption of pricing reforms and their success. For example, reliance on the pricing mechanism can seriously disadvantage low income groups when the supply of water is limited. There are, however, workable solutions to overcome these constraints including compensation and political transparency.

An appropriate scheme for managing the demand for water in order to improve its efficiency of use is incentive pricing where water is priced per cubic metre, perhaps in conjunction with a fixed charge. A good tariff is one that encourages efficiency, provides revenue for the supplier and is understandable and fair. Where there is no fixed charge there can be unacceptable variations in income, particularly where water supplies are subject to volatility.

Among the participating countries, only Egypt and Turkey remain committed to developing large publicly funded water resource schemes, i.e. supply management. Spain, Portugal Italy and Israel have recently shifted their attention to demand management for water. In the EU countries, there is an added impetus to pricing reforms from the need to modernise agriculture and make it more efficient and competitive.

Although there is evidence that domestic and industrial consumers react to high prices by using less water, the situation in agriculture is less clear. The elasticity of water demand appears to depend not only on the price of water but also on the choices available to farmers. Where cropping options are limited, holdings are small and agricultural labour is mainly part-time, increasing water prices can lead to a return to rain-fed agriculture or abandonment of the land. The most important option to a farmer is to change to a crop that consumes less water, although it is likely to be a less valuable crop. Farmers need incentives to invest in better, more water-efficient irrigation methods rather than just to change to a lower value crop.

- Pricing of agricultural water must be based on sound economic principles.
- The adoption of reforms based on the principles of “full cost-recovery” and “user-pays” may be hindered by political, social and cultural traditions and the structure of agriculture.
- The key to success in pricing reforms is to be aware of these constraints and to take account of local problems and priorities when formulating the pricing policies.
- in a few circumstances, pricing may not be an effective management tool.

Table 7. Water pricing

Land ownership patterns and agricultural water use

Introduction

The study by IPTS on land ownership was carried out as it was felt that ownership of land would have a large effect on decision making by farmers.

Objectives

The objective was to develop an analytical framework defining the relationships between land tenure, property rights, water rights and water use efficiency (and indirectly farm productivity and crop yield).

Methodology

A questionnaire was prepared, sent out to the partners and discussed with them.

Results

Key questions to be resolved are:

- are large farms more productive than small ones?
- do large farms impact more on water and soil resources than small ones?
- how do land ownership patterns influence the use of water by agriculture?

The answers to these questions can then be used to evaluate land reform policies in terms of their impact on the efficient use of water.

Most Mediterranean countries are arid or semi-arid and so water is a limiting factor. In countries such as Egypt where land is also a limiting factor water ownership tends to be more important than land ownership. Water ownership includes the concept of water rights.

In order to understand how water ownership functions, we must take account of land ownership patterns. This calls for a definition of "ownership" (land tenure or property rights), in particular in the Mediterranean context characterised by structural resource scarcity (water and/or soil).

Traditional views differentiate property into private, public, and common domains. These notions, however, do not have the same meaning everywhere. Often, there is a tendency to use the nature of the property regime to explain economic and environmental problems. However, this descriptive form of analysis provides little insight into the underlying mechanisms and the results cannot be used reliably to predict the effect of changes in land tenure on water consumption.

Data on water use efficiency as related to farm size and land tenure are difficult to find as they are not usually measured. Water use efficiency is usually related to plot yields or "farm productivity". In a recent study on farm productivity and land ownership in Bangladesh, it was found that the single most significant factor affecting plot yields was soil fertility and not farm size, land tenure, or farm fragmentation. In that particular context, land reforms do not necessarily increase farm productivity. Factors such as water rights and institutional water supply structure, the presence, rights, and impact of water users' associations seem to be more important in determining water use efficiency and thereby farm productivity than actual property rights.

It is then necessary to seek alternative analytical approaches based on a combination of socio-behavioural studies of farmers' agricultural practices and of their relationships to the water and soil resources, institutional behaviours (institutions considered both as human entities and as objects), and the ecological characteristics of the resources themselves.

• The concept of ownership needs to be defined carefully as it involves more than property rights • The definition of private, public and common property can differ between countries and cultures • There is no clear link between farm size and productivity • Water rights and water supply structures seem to have a greater impact on water use efficiency and thus farm productivity than actual property rights

Table 8. Relationships between land ownership patterns and agricultural water use

Agronomic and Economic Limitations

Introduction

The Israeli and Italian partners carried out this study using their expertise in the economic and agronomic aspects of water use efficiency. Research into these aspects has been carried out for many years. However, scientists, economists and technicians tend to use different concepts and these can be difficult to link together in the integrated manner required for effective policy making. The partner countries covered the whole range of environmental and social conditions experienced in the Mediterranean basin and the findings are thus considered to be applicable to the whole of the region

Objectives

The objectives of the study were to:

- disaggregate the overall water use efficiency into components that are influenced by policies to promote water-efficient agricultural exploitation systems
- identify quantitative indicators for assessing the efficiency of agricultural water use
- consider how to take account of economic, social and environmental aspects of efficiency

Methodology

The partners used information from the vertical studies carried out by the six collaborating countries and from a questionnaire to those countries as well as some more detailed case-study data from Italy and Israel. The quantitative data were analysed in order to establish the usefulness of alternative ways of summarising the information. Qualitative information was used to establish important constraints and to assess whether there are situations where the derived quantitative indicators would be misleading. Simple efficiency ratios are easy to calculate but take no account of changes in efficiency with the amount of water applied. In both Israel and Italy there are farms where water is already used efficiently and case study data at a sub-catchment scale were used to evaluate the response of crop yield to water supply.

Results

Quantitative indicators

The relationship between the amount of water available to crops and their yield can be considered the resultant of several processes. Each can be used as an indicator to identify the areas where there is the greatest possibility of improving efficiency. Although comparisons between countries are complicated by differences in definitions, methods of data collection and other circumstances, the analysis of trends in indicators within a country allows useful conclusions to be drawn

Physiological efficiency is the ratio between crop yield and the amount of water transpired by a crop. The large differences between crops are mainly due to the proportion of the crop biomass that is actually harvested and to its water content. The effect of agro-climatic zone is relatively small and can be taken account of by using relative humidity as a normalising factor. Crop cultivar has a relatively small effect, particularly at a regional scale. The biggest efficiency gains to be made here are from changing from one crop to another. However, it can be profitable to irrigate a crop that is a profligate user of water if its value is high enough.

Agronomic efficiency is the ratio between the amount of water available to the crop and the amount transpired. This complex attribute depends on the agronomic practices adopted and the level of knowledge and skill of the farmer. These practices affect the ability of the crop to take up water and the proportion of the water that is actually transpired through the leaves and not lost by evaporation from the soil surface. Drip irrigation can be very efficient because the water is applied directly to individual plants and bare soil is not wetted for long periods of time.

Technological efficiency is the ratio between the amount of water available to the crop and the amount available from a source of irrigation water. Losses here include run-off from the soil surface or deep drainage caused by the application of excess water, evaporation of water before it reaches the soil surface and any losses from leakage from pipework in the field. Flood irrigation can be very inefficient unless the run-off is used to irrigate other fields, which will only be effective if the water quality is not impaired by contamination with excessive levels of salt. Considerable amounts of water from sprinkler irrigation can be lost by direct evaporation unless the droplets are large or irrigation is carried out at night.

Delivery efficiency is the ratio between the amount of water available in the field and the amount abstracted from the source of water. Losses in this case come from leaks in pipes or from evaporation losses from open channels. Where the water is transported long distances, as in Spain, losses can be very high. The effective delivery efficiency can be increased by recycling water draining from other irrigated areas and by the re-use of wastewater. In the latter case the efficiency could exceed 100%.

Economic efficiency, which is the added value of a crop per unit application of water, depends on the physiological, agronomic and technological efficiencies, the price of the water, the proportion of the crop that is saleable and the market price. It is thus complicated by the value of the currency and any water subsidy.

Response curves could be used to examine the relationship between the crop yield and the amount of water applied. However, although a single curve can be derived for many crops, the parameters were found to differ from region to region. For fruit trees no simple relationship could be defined.

Qualitative indicators

Social efficiency is a difficult concept that includes issues of social equity and the impact on rural employment. The issues that are important thus vary from country to country and it is difficult to develop a single indicator applicable to the whole of the Mediterranean basin.

Environmental efficiency can be quantified as the degree of groundwater pollution by nitrates or salt, loss of biodiversity, or the amount of erosion. However, a whole series of indicators would be necessary to take account of the circumstances in individual countries. Qualitative indicators can be developed. However, targets and thresholds already exist for many environmental factors and this seems to be a better approach.

Strategic efficiency is something that particularly affects Israel. It is not really an efficiency at all but represents the effectiveness of investing in irrigation for attaining political and security goals.

Factors affecting water use

Not surprisingly, the availability of water was the most important factor affecting water consumption in agriculture. In some countries, however, reliability of water supply, i.e. variability within and between years, is almost as important. Water pricing and quotas can influence water use but were usually set below the level where this result would be seen.

- There was considerable variation between and within countries in their overall efficiency of water use and in the particular factors resulting in inefficiency
- Agricultural, technological and delivery efficiencies can be defined unambiguously and used to identify sources of inefficiency and monitor the effects of policy changes
- Much of the information required is not routinely collected in a standardised manner and where it is collected it is often aggregated at an inappropriate scale
- Economic and Social efficiencies are difficult to define and their use is complicated by the differing social and economic objectives of the partner countries
- Environmental efficiency is not a very useful concept as environmental policies are generally based on thresholds, which vary according to the conditions in each country
- It is possible to achieve efficiencies near the theoretical maximum but there may be unacceptable economic, social or environmental consequences

Table 9. Optimal water use: Agronomic and economic considerations

Conclusions

The partners taken together had experience of a wide range of policies and management structures, and their consequences and the partner countries covered virtually the full range of environmental and social conditions in the Mediterranean region. However, although each partner provided at least some information for one or more of the horizontal studies, there was less sharing of information between partners than had been expected, partly because some issues were perceived as being of less importance in some countries, and partly because many of the studies were focused strongly on the conditions in the country of the partner responsible for the study. This was probably inevitable given that the partners had naturally most experience of conditions relevant to their own country. Indeed, one of the results of the studies was the diversity of the key issues affecting water consumption between and even within countries. Although the partners were more effective in identifying key issues than in quantifying the trends, results were derived that could be applied to new situations such as when policies change.

In a number of the studies, it proved extremely difficult to obtain quantitative data as these were not routinely collected at an appropriate scale. The issue of scale is an important one. Data aggregated for Italy as a whole, for example, hide the very real differences between the north and the south. Comparisons between countries were complicated by different definitions being adopted and different data collection methods being employed.

Many of the studies turned out to be less independent of one another than was initially hoped. For example, the water pricing and trade policy studies were linked through the principle of full-cost recovery. Some overlaps were removed in the editing phase.

Regional infrastructure development and education and extension policies were not treated explicitly. However, the former was touched on in the sections on major donor policies and on EU regional policies while education and extension work influencing water consumption is often not a result of specific policies but rather a consequence of other activities such as capacity building or water management. It was interesting that several of the partner countries did not actively manage water demand because the physical limitations to the availability of water were not recognised by policy makers.

An important topic that was omitted from the study programme was that of climate change. This topic has been well studied elsewhere. The prognosis is not clear, particularly with regard to the amount and seasonal distribution of rainfall, but it is clear that any significant diminution of rainfall or reduction in reliability will have a large effect on irrigated and rain-fed agriculture in the Mediterranean region, particularly where existing resources are almost fully utilised already. As was alluded to in some studies, agricultural water use cannot be divorced from water use as a whole. In some parts of the Mediterranean region there is already strong competition for water between agriculture and domestic sectors. Another topic that was mentioned is affect of the availability and cost of transport on the types of agriculture practised. Much of the produce of the Mediterranean region is exported to the markets of the north and depends on the provision of cheap, rapid transport. The environmental costs of transport are increasingly coming under scrutiny but vary considerably with the mode of transport (ship, rail, truck) used.

Chapter 5

5. FROM WATER SUPPLY TO WATER DEMAND: THE PROSPECTIVE APPROACH

Introduction

Having carried out descriptive studies into individual countries and a wider analytical investigation of issues affecting the evolution of water use, the next step was to develop methodology to predict what water consumption is likely to be in the future. The objective of the scenario phase was to examine the effects of interacting policies during the decision-making process that is agricultural water management. This complex interaction of policies is difficult to model, so investigations were made into the interaction of sectoral interventions within water policy formulation and the decision making process. We assumed that scenarios would involve demand management, e.g. by water pricing and education. Currently, most countries manage supply, e.g. by investing in infrastructure, and this is considered to be unsustainable. Part of the work was therefore concerned with examining the importance of demand management.

Methodological considerations

Development of the prospective study

The scenario analysis methodology was chosen to enable simulation of:

- the implementation of policy changes towards demand management, and
- the consequences for agricultural water use and the regional socio-economic situation.

After various discussions and adjustments, the following procedure was agreed:

1. Identification and critical analysis of current documents related to water planning including official and other planning scenarios and descriptions of the water planning process; identification of the place accorded to demand management in these documents
2. Identification of people to be interviewed (from the analysis of the water planning process)
3. Choice of a scale of analysis (e.g. regional, national, etc.) and of a planning document upon which to base the study
4. Critical analysis of the internal consistency of the planning document chosen
5. Interviewing experts and stakeholders to identify alternative scenarios particularly those involving demand management
6. Building a demand management scenario
7. Discussion of the demand management scenario and its political acceptability with experts and stakeholders
8. Identification of the factors constraining the development of a real demand management policy

For each scenario the outputs should be:

1. a sequence of demand management measures (preferred technical options)

2. an assessment of the feasibility in the short, medium and long term of demand management measures (including the amount by which agricultural water use is expected to be reduced and any political barriers to change)

3. an analysis of the interactions and the systemic functioning of the "agricultural water use" system (including environmental, economic and social impacts)

Data related issues and adaptation of the method

The analysis was complicated because not all the documentation was easily available. Procedures had to be modified to take account of differences between the partner countries. Diverse planning processes and institutions resulted in different scales of analysis, variation in the degree of quantification in planning documents and demand management scenarios, and the number of rounds of interviews needed. However, the final products were comparable.

Evaluation of the methodology

Table 1 presents an overview of how far it was possible to implement each stage in the methodology in the six partner countries and identifies limiting factors. Key issues affecting the success of the process were:

1. the existence of a planning document organised in such a way that it is possible to abstract the information needed

2. consistency in the scale in the planning document and data sources

3. a quantitative planning scenario

4. the possibility of developing an adequate and complete demand management scenario

5. the possibility of interviewing experts, planners, and decision makers

6. the status of the water debate in each country

Cross-country comparisons

	Portugal	Spain	Italy	Turkey	Israel	Egypt
Existence of a planning document	Plan available for irrigation	Important planning process and debate on water	No national plan. Few regional plans	Plans exist but they are broad outlines	The official plan is a demand management plan	Very difficult to access to the documents. A plan is available for irrigation
Scale chosen for the scenario analysis	The public schemes and the water scarce regions (for data availability purposes)	The three Mediterranean basins (water scarce and most important agricultural sectors)	Sardinia (the region is the scale at which planning and policies are implemented and data are available)	The whole country, with a qualitative discussion about water scarce regions	The whole country	The whole country
The planning scenario : qualitative / quantitative	Figures are available, but not useful for discussion (maximum needs calculations)	Figures for the three basin plans are analysed	The figures for the scenario are analysed, but there are none for efficiency	Figures are available, but not useful for discussion (maximum needs calculations)	Figures are available	Figures are available from various sources, but not always consistent
The demand management scenario : qualitative / quantitative	Scenario based on a quantitative prospective inquiry on the time frame and impact of demand management measures	Scenario based on a systematic analysis of the qualitative and quantitative impact of alternative demand management measures to the plan	Discussion, for each demand management measure from the plan or outside the plan, of the impacts and barriers to implementation	Based on the interviews, qualitative narration of the succession of events (causal paths) leading to demand management or not	Questioning the possibility of implementing the ambitious demand management plan : alternative scenarios if external factors make the plan difficult to implement	Discussion, for each demand management measure from the plan or outside the plan, of the impacts and barriers to implementation
Interviews	Iterative expert consultation, in order to reach consensual figures of demand management measures and their impacts	Discussion *ex post* of the alternative scenario and its validity with the experts	Interviews for the Critical Analysis phase	Interviews for the Critical Analysis Phase and for the Construction of the alternative scenario	Some expert consultation	Difficult to access experts expressing a critical point of view on official documents; Experts consulted for the critical analysis

Table1. Inter-country comparisons of the stages of the prospective approach

The sample of countries selected represented a good sample of diverse planning regimes ranging from centralised, established and technocratic national planning systems (Israel, Tunisia and, to some extent, Egypt) through more or less participatory planning and policy making involving regional levels of decision making (Spain) to systems with a large degree of regional and local autonomy in any which central planning plays only a small part (Italy). The organisation and process of water policy and planning is an important element in the feasibility of demand management. The diversity of the cases studied enabled us to explore a range of interactions between policies and stakeholders. The method was developed for countries where the planning process is exhaustive and well documented. Here it was difficult to base the critical analysis of the current policies only on the available figures. The work also highlighted the need to check the consistency of information as missing data had to be derived from the opinions of experts and decision makers. At the very least, however, the studies identified the importance given to demand management and of problems emerging from the policy formulation process itself.

Conclusions

The prospective phase successfully provided a link between the analytical and recommendation phases. The methodology was adapted to very different contexts and constraints and enabled people with very different disciplinary backgrounds to adopt a common policy analysis approach, even though they may have been reluctant to use the scale and time dimension of the analysis or the interview approach.

In fact, an important output of this work turned out not to be the scenarios themselves but the experience of implementing the methodology in a wide range of circumstances. In the present context, this framework appears to be a good basis for designing an inquiry methodology to tackle the possibilities of implementation of emerging demand management policies. It is clear that the focus of this methodology is the balance between demand and supply. The methodology was not designed for situations where demand management issues are not being tackled. The long-term dimension is necessary when tackling policy change issues because policy changes can take a long time to implement and the evolution of the system in response can be even slower.

It is clear that such a general framework could be used successfully for further interdisciplinary applied research on policy change themes and that economists, agronomists and environmental scientists could use this methodology of the social sciences.

Policy change towards demand management

Cross-comparison of countries' scenarios

The key differences between countries are given in tables 2 and 3.

Some work was carried out on Tunisia[7], which belongs to the group of countries where water resources are already nearly completely mobilised. The objectives of the water mobilisation plan are nearly achieved and a demand strategy is in place, although the future doubling of the

[7] Tunisia was one of the partners, but left the project at its onset. Nevertheless, some data was also collected on the status of agricultural water use in that country (ENGREF/BPRAC).

irrigated area is still planned. Demand management is still seen as restricted to sectoral water savings, even though the national strategy is to allocate the mobilised freshwater between sectors and regions taking account of the efficiency of water use. The planning process is centralised and the water supply network and water allocation is controlled by the state.

	Portugal	Spain	Italy	Turkey	Israel	Egypt
Present importance of demand management in water policy	Water resources are hardly mobilised; Some loss reduction measures; Demand management is not a priority: it is considered important to develop water resources to facilitate farming; demand reduction would have very little impact on the global water balance.	In the Mediterranean basins, water resource mobilisation has reached saturation; Loss reduction is implemented, but is considered marginal; No reflection on the definition of the water needs and on national water allocation; Development of water transfer from North to South is still the major issue.	Water resources are scarce only in particular regions; Scarcity is not seen as caused by increase in water demand but by low water availability; Demand management is seen only as increasing the efficiency of the hydraulic infrastructures, and in line with development of new resources.	At the national level, water resources are still little mobilised; Emphasis is on the development of resources; demand management is understood as reducing the loss within each sector; no reflection on the global allocation of water.	Natural water resources are already totally developed; Water saving measures are already implemented, and losses have been very much reduced; The states allocates every year water to the various users and therefore debates water allocation every year; New resources to be developed are desalination, treated wastewater, and water imports.	Renewable freshwater resources are already mobilised; Water savings are already implemented, in order to increase water use activity with the same water; The allocation between sectors depends on historical trends of development; Important new resources are sought for the 2nd valley (fossil aquifers, better mobilisation of Nile water upstream of the Aswan Dam).
Regional autonomy and diversity / national coherence	Differences between North (traditional irrigation systems) and South (arid regions, recent irrigation).	Autonomous regions and Hydrographic Confederations have significant autonomy, and diverse water balances; National decisions on inter-regional water transfers makes the regional systems interdependent.	Very diverse and autonomous regions, without a central planning level.	Very different regional contexts, particularly in terms of water scarcity; They are not interconnected but the central hydraulic administration (DSI) has strong powers.	Diverse arid regions within a small country, but all interconnected through the National Water Carrier and national water allocation; The Palestinian territories depend on the same water resources.	Egypt's water usage is dominated by water from the River Nile which is managed centrally.
The planning process	A non-binding central- and basin-level planning process, not binding anticipates possible water resource developments.	Long and iterative process, at the regional (basin) and national scale, with significant public debate; the results should be binding; decisions on hydraulic works are made by the state; No consideration of the efficiency of water allocation in spite of the debate; the national bodies accept without discussion the water demands of the regional authorities.	Very significant diversity of planning processes at scales that can overlap (regions and basins), and be affected by other policies (water policy, structural funds, etc.); None present a projection of water demand: they are rather objectives and strategy statements.	Plans exist at the national and regional level; they are designed by the administrative bodies and are either broad outlines for economic planning and state investments, or engineering plans for particular projects; Debate about hydraulic options, does not lead to discussion of the appropriateness of future water needs.	Very centralised planning process, able to decide the development of the various water uses, and particularly of irrigation; But the social and political conditions to, or impacts of, this water planning need to be studied more deeply.	Plans deal with planning public work projects, and do not intend to control the evolution of water use; Except in the case of extraordinary drought, it is difficult to imagine implementation of a real reduction in the water amount allocated to agriculture.

Table 2 Differences between countries in the water planning process

	Portugal	Spain	Italy	Turkey	Israel	Egypt
Sectoral policies influencing agricultural water use	Rural development policies and EU structural funds; Geopolitical context: influenced by developments upstream in Spain.	Public works culture; Economic development of rural regions is considered very important in the national water plan debate; EU Structural funds policies contribute to water resource development policies; The uncertain future of the CAP is a major determinant.	Important impact of CAP subsidies and WTO regulations on the cropping pattern and thus on water consumption; Employment and rural development policies are implemented at a regional level	Energy policy is the main reason for developing hydraulic works, which are then used for irrigation; Donors' policies are encouraging demand management through formation of water users' associations or pricing; EU environmental legislation is important because of harmonisation; Food security is not considered an important issue	Regional development policies; R&D investment for treated wastewater re-use; Investments in desalination; Land use policies (high competition for urban use of agricultural land); Political situation in the Middle East; In time of tension, food security can become an important issue.	Agriculture liberalisation policy and free trade agreements with the EU; Political relations with the upsteam states; Social and rural development policies (2nd valley);Donors' policies.
Demand management solutions recommended	Reduction of distribution losses and progressive introduction of water pricing; Education; Change in technology and practices	Take into account the whole diversity of possible demand management measures (loss reduction; modernisation of water use equipment; controlling water-using activities like tourism, golf courses, and very water demanding crops; changing the cropping mix); Developing the possibility of allowing a water user to sell any water saved	A European or national environmental legislation would be the only way to push demand management forwards; Influencing the farmer's behaviour (cropping pattern, irrigation technology and practices) through: subsidies, prices, education, and organisation of the agricultural sector; Reduction of distribution losses and improvements in technology when possible	Simultaneous implementation of resource development and demand management; Progressive introduction of pricing; Co-ordination between the central planning, water management and rural engineering administrations; Taking into account water scarcity issues in the energy policy.	Loss reduction, modernisation of irrigation techniques, metering devices, stepwise pricing policy, redefinition of the allocation of natural water resources (less natural freshwater and more treated wastewater for irrigation); Water quotas could be even better allocated if a market of these quotas could be prudently organised.	Limitation of water demanding crops; New, less water demanding crop varieties; Water users associations; Some cost recovery; Improving irrigation technology; Public awareness campaigns
Roadblocks to demand management identified	Difficulties in involving farmers; Policies against the abandonment of farming :pricing is seen as a limiting factor for the viability of the farm	Design of the planning procedure; Importance of the traditional public works hydraulic culture; Regional development needs; Agricultural policy's impact on cropping choice	Irrigation and hydraulic works development for social and employment purposes; Fragility of the farming systems makes pricing dangerous and difficult	Situation of under-development of hydraulic infrastructure; Energy policy decisions.	The risk is that, with even less water available than is planned, the agricultural sector could suffer very drastic changes; High vulnerability of the planned demand / resource balance to external pressures (climate change, war or peace, economic growth)	Influencing the farmer's choice is only possible through incentives which may not be permitted when agricultural trade is liberalised; The planned development of irrigation may be endangered because of context modifications.

Table 3 Policies, solutions and obstacles to water demand management

It is clear that in the long term the amount of freshwater allocated to agriculture in the Mediterranean countries will have to be reduced, and that the agricultural sector will increasingly rely upon treated wastewater. Such demand reduction should be anticipated and the agricultural sector re-organised so that it can adapt to water scarcity and market changes. The "national solidarity" principle that pushes for the development of a national interconnected network instead of reducing water demand in the regions where water is scarce makes the transition to demand management difficult in some countries.

Demand management in the current policies: a typology

In cases where only a small proportion of renewable water resources are utilised, demand management is often not seen as necessary since water savings have only have a small impact on the exploitation index. Increasing the efficiency of agricultural water use is best tackled by ensuring that the performance of new funded projects is high, e.g. for financial reasons. In other situations, a very high proportion of the renewable water resources is already developed and mobilised, and further mobilisation of water will be increasingly. In these cases, there is a clear link between water savings and overall efficiency. This means that demand management in its broad meaning is taken into account, and that re-allocation of water between sectors could be considered (see the Israeli case).

These categories apply not only to countries (Portugal is in the first category, Israel in the second), but also to regions (Northern Turkey is in the first situation and South Western Turkey in the second) and even systems within countries or regions. For example, in Tunisia, private irrigated schemes generally over-exploit aquifers whereas the public irrigation schemes supplied through the national water supply network are in the first category because the schemes were developed recently and farmers do not yet use all their allocation. However, not all situations fit into these two categories. Water savings are considered only to have a marginal impact in the Sardinian plan in spite of structural water shortage.

Over time, countries move from the first to the second situation. A choice has to be made between implementing pre-emptive demand management measures, so as not to reach the second situation, and continuing the mobilisation of the resources and being prepared for the implementation of more severe demand management measures once the second situation is reached. Theoretically a cost-benefit evaluation could be made of both trajectories but there is too little experience of demand management and too much uncertainty in the underlying assumptions for this to be useful for decision making. One of the difficulties of the demand management trajectory is that inertia in the agricultural system makes it difficult to reduce agricultural water use rationally if a re-allocation of water between sectors becomes necessary,. An argument against demand management is that shortages of water will encourage technological innovation which will increase the availability of cheap water. For example, in Tunisia, the rapid over-exploitation of aquifers resulted in the development of the techniques of artificial recharge. The capturing of floodwater for this purpose has now become a major component of the Tunisian water resource mobilisation strategy.. However, there are limits to how far technological progress can help and the levels of shortage needed for rapid progress may have passed beyond the threshold for preserving the natural functions of aquatic ecosystems.Where water resources are apparently under-utilised, there is a problem of political acceptability of demand management measures. The state needs to have developed new resources and mended leaking pipes in the public distribution networks before any effort can be asked from the individual user.

Even where mobilisable water resources are scarce, there is still a choice between developing water transfers, desalination, or non-renewable resources, and reducing or controlling demand. In both cases the water planner should study the whole range of demand management options because the overall efficiency of water use has to be taken into account to allocate the water from any new and costly resources that can be developed. In the case of Tunisia and Egypt, the water planner has first to consider technical demand management measures, as questioning the traditional division of water between users poses difficult problems of political acceptability. However, many Mediterranean countries have been through, or will soon, go through a demographic transition to lower birth rates that could allow an easier transition from an exponential to a stabilised water demand.

However, reducing or stabilising agricultural water demand may be inevitable, because agricultural users may not be able to afford to use new and non-conventional resources such as desalination, non-renewable aquifers, and treated wastewater as it is unlikely that the state would subsidise them at the same rate as has generally been done for hydraulic works. The sustainability, quality, and environmental impact of these water supply techniques are also still subject to debate. These characteristics make non-conventional resources quite different from the conventional ones. The experience of Egypt and Israel is of great relevance for other Mediterranean countries and regions experiencing water scarcity. There, the water supply has been augmented from treated wastewater while controls have been imposed on the amount of water available for agriculture.

Regional diversity and national policy

Among the various examples studied, there is a very significant diversity of regional situations both in terms of availability of water resources and in the economic stage of development. Within Turkey, for example, the available freshwater in some of the Mediterranean basins have already been completely mobilised, whereas in Anatolia, there is still a lot of scope for further water resource mobilisation. Moreover, in countries such as Italy, the regions have significant political autonomy. For water policy, the region and the basin and not the country are the appropriate planning scales for implementing demand management.

On the other hand, the national scale is appropriate where there are institutional and physical water interconnections between regions. The Turkish regions depend upon a central authority that co-ordinates the water demand management policy while Spain, Tunisia and Israel transfer water between regions. The possibility of water transfers is doubly detrimental for demand management. first, it removes the pressure on local or regional policy-makers to think seriously about demand management since they believe that new water will come from other areas, and secondly, for reasons of political negotiation (as during the Spanish National water planning debate), it forces them to downplay the possible effects of demand management measures, both on their own constituents, and on other regional or national actors. Such water transfers are linked to a national land use planning policy (inter-regional balances of population and activity) where the power relationships between the regions and the central state are very important. The power evolution process is very obvious in another Mediterranean example: the Palestinian Water Authority has imposed its power on traditional water-using communities through its new water distribution network. But we could also instance the Tunisian state developing irrigation in Southern Tunisia in order to keep its authority over it. Geopolitical factors and power competition between political institutions for territory can assume more importance than water efficiency and can prevent demand management measures from being implemented.

Planning processes

The cases studied here show the very important diversity of political contexts and planning and policy making processes. Centralisation of the planning process should make overall national evaluation of water use efficiency, and therefore this level of demand management, easier to implement effective allocation between sectors. However, regionally-based participatory planning seems to hold out the best hope of effective implementation of the water policy. All the planning systems encountered in the study had problems that would hamper efforts to implement demand management.

It is true that in Israel there is the possibility of reducing agricultural water use through water quotas that enable a decision to be made on global water allocation every year. However, states with centralised water planning still tend to be strongly influenced by an “engineer culture” that favours the development of large-scale hydraulic works for political reasons (Tunisia, Israel, Spain, Turkey, France) and this goes against demand management.

Participatory planning enables more stakeholders to be part of the debate, planning and decision and thus stakeholders in favour of demand management policies should be able to voice their opposition to a potential central hydraulic works decision. Here it is important to distinguish between participation that includes all current water users, and a broader participation that would include other stakeholders affected by the water plan. There are also problems where the advantages and disadvantages of a scheme affect different stakeholders or people in different regions. However, participation is neither a guarantee of the democracy of the procedure or of its efficiency. In Spain, the way the debate has proceeded has led to a situation where the central government has not utilised the procedural opportunities to challenge the claims of the regions and basin organisations and has, in effect, made a "non-decision" to accept these claims as if they were facts. Often the general planning debate enables stakeholders to take part in the decision making but opponents of hydraulic works and the increased mobilisation of water resources often focus on minimising the impact of these schemes rather than discussing the national efficiency of water use and the real need to build them. The power of the agricultural sector in the water planning debate is also very important. Key questions here are whether it is possible to question the efficiency of agricultural water use in a public decision process, whether it is possible to reduce the amount of water allocated to agriculture, and whether it is possible to impose demand management measures on agricultural users.

Factors determining future agricultural water use

As we have seen in the preceding sections, future agricultural water use may be constrained directly by water scarcity, or indirectly by national or regional decisions policy decisions. However, the main uncertainty over the evolution of agricultural water use is from factors that are external to the system:

- future market prices for agricultural produce
- the Euro-Mediterranean partnership negotiations

- free trade zone agreements
- EU Directives on agriculture and environment
- donor policies on funding hydraulic or agricultural projects
- climate change.

The evolution and impact of these external factors are not easy to foresee for Mediterranean states, even if they are EU members. For example, it is unclear what types of agriculture would be competitive in a Mediterranean free trade zone.

State planning faces considerable difficulties in all the Mediterranean countries because of this inability to make reliable forecasts of the future agricultural water use in the medium or long term. Thus, demand management policies have until now been used as a means to increase the efficiency of water use but without having too severe an impact on the profitability of agriculture, e.g. through water pricing, and putting farmers at a disadvantage to competitors from other countries. For instance, it is not clear to the Portuguese Ministry of Agriculture that irrigation will survive in Portugal even though there is enough water. The uncertainty comes from the effect of factors such as a diminishing agricultural labour force and lack of competitiveness on the evolution of the agricultural sector. In Israel also, many factors, including large-scale purchase of agricultural land for urban use, could impact deeply on the level of agricultural activity. .

An important question is how to make the irrigation sector more resistant to market changes and water scarcity problems. The demand management measures that have already been implemented focus on saving water and help make the individual farming enterprises more profitable and competitive. However, more general discussion about demand management should include a reflection on the efficiency of the allocation of water between sectors. Taking account of the underlying uncertainties, the goal should be to move from a situation of *preparing the agricultural sector for a possible restriction on its use of water* to *making the agricultural sector more adaptive to change including water use reduction.*

At the Bari Conference of September 1999 on *Water for food in the Middle East and North Africa region* it was agreed that food self-sufficiency is no longer the driver for the development of irrigation in the Southern Mediterranean because every country more or less acknowledged that they had to deal with some inescapable food dependency, and that the important concept was food security. High value crops for export are important for ensuring affordability of necessary food imports, but they are not always irrigated and the geopolitical component may be as important as the economic one. Thus, the politicians who were present at the Bari Conference stated that the development of irrigation was to achieve social and employment goals for rural areas. However, given the uncertainties presented before, it may be questioned how far these goals are actually achieved in the Mediterranean states as a whole.

Irrigation development can also occur as a side-effect of energy policies. This is the case in oil-dependent Turkey, which has chosen to develop hydro-electric rather than nuclear energy, and therefore has a very significant dam-building programme. The water impounded will also be used for irrigation. In this context, global water use efficiency (particularly, the efficiency of the allocation between sectors) is not being decided by the national water or agriculture policies, but as a consequence of the national energy policy.

Conclusions and Recommendations

The diversity of obstacles to the implementation of demand management policies is very significant. They include: political acceptability, national political choices preventing demand management at a regional scale, and power relationships within a planning process. Additionally, various factors external to the decisions of the national water and agriculture policy makers will have a major but very uncertain influence on future agricultural water use. National political decisions aim to provide the works needed to avoid infrastructure constraints on the development of irrigation. It seems to be clear that for nearly every agricultural or irrigation planning agency in the region the planned development of irrigation follows the most optimistic scenario of agricultural water use evolution.

The first set of recommendations made during the scenario phase was very much linked to the technical or economic solutions for improving water use efficiency that would be acceptable to farmers and which thus could be implemented successfully. At that stage, a discussion on recommendations could not take place between the various country teams and so it was not possible to identify at the country level the ways of altering the socio-economic and political situation in order to make demand management more feasible. We were, however, able to consider these changes more generally.

Water saving solutions

Recommendations made by the partner teams related to water demand management measures that are considered useful, feasible and acceptable, rather than making possible the implementation of demand management measures.

1. The choice of measures needs to be adapted to the regional situation (stage of mobilisation of the resources, political context, climate, agricultural sector strength, etc.). The available technical solutions are not all appropriate for all contexts.

2. The same is true of organisational change as the success of a particular solution depends on the historical context of the agricultural sector in the region of interest.

3. It is important to be aware of any systemic efficiencies at a larger geographical scale. For example, water losses from a local farming system in Egypt can be re-used further downstream and also permit effective leaching of salts. The systemic efficiency may be high at a regional level even though the local efficiency is low. This needs to be considered when prioritising a change in irrigation techniques to improve efficiency at a local level.

4. In some cases, water use efficiency has been increased by re-organising the irrigation sector into water users' associations.

5. Water pricing policies should be implemented gradually, beginning with the installation of water meters, then instituting a price per volume used, rather than per irrigated area, and ultimately recovering an increasingly high proportion of the real costs.

6. Another possibility for giving value to water would be to permit selling of water to other users (from agricultural to urban users for example). However, this needs to be carefully piloted and tested beforehand and a strong administrative structure put in place. Such a procedure would be useful in Israel where a market for water quotas may be set up.

7. Investment in the treatment of urban wastewater can reduce the demand for high quality water by agriculture.

Conditions for policy change

In the preceding sections, we noted that some spontaneous change could lead the policy maker to more account of demand management measures. We have been trying to describe more precisely what is often hinted at as "political acceptability". The rather erratic pathway from resource development oriented policies to demand oriented ones can be summarised as follows:

1. A rather general feature of agricultural water use is that external pressures in general lead to some inefficiency in overall water use, and even to a perception of scarcity or unsustainability for agriculture.

2. One solution has been to increase the mobilisation of water resources, an option no longer available to many Mediterranean countries.

3. Another solution is to conserve water by decreasing water use per capita or by recycling.

4. However, these two solutions appear not to be problem solving, for at some point resource development will lead to water becoming too costly for agriculture, and for water conservation if the water-using activity keeps growing then water demand will keep increasing and the onset of scarcity will only be delayed.

5. The only solution left is one that has been rejected before because it was too difficult to implement: a policy change towards real demand management.

6. Thus, the logical evolution over time of agriculture and water policies seems to result in questioning the justification of present and past resource development policies.

7. The conditions for this policy change are the acceptance of the necessity for doing this.

Chapter 6

6. FUTURE LINES OF RESEARCH

The POLAGWAT workshop on Water, Land, Agriculture and Policies in the Mediterranean (Brussels, 19-20/04/01)

Participants from 13 countries coming from various projects and disciplines attended the workshop on *Water, Land, Agriculture and Policies in the Mediterranean* (Brussels, 19-2004/02).The impetus for the workshop was twofold. First, the need observed during the course of the POLAGWAT project to create a synergy between similar research projects through the elaboration of a research network. Second, the need expressed by the European Commission to disseminate the results of EU funded projects during the course of a project. Indeed, during the last Inco-Med co-ordinators' day organised by the EC (DG Research)[9], it was recognised that:

- too few projects involve multi-interdisciplinary work and they do not integrate the social, economic, institutional, technological, and scientific dimensions of policies related to water and agriculture in the Mediterranean regions;
- there is benefit in exchanging ideas, methodologies, and results of similar projects through a workshop where communication among individuals takes place
- the creation of a network on research and policies issues related to the management of natural resources and agriculture in the Mediterranean area would be beneficial.

The workshop had four *objectives*:

1. to delineate lines for future research in the Mediterranean
2. to provide the building blocks for the creation of a network for sharing common multidisciplinary methodologies and research interests about integrated management of natural resources (soil, water etc.) and agricultural research in the Mediterranean;
3. to exchange results and ideas on specific topics arising from multi-interdisciplinary projects in the Mediterranean region;
4. to make a synthesis of recommendations to the EU concerning multi-interdisciplinary projects and future research lines in this field.

In practice, it turned out that a fifth objective was achieved in that the results from the POLAGWAT project were validated by workshop participants from other projects, disciplines and cultural backgrounds. What was first considered as duplication of discussion turned out to be a demonstration of a high degree of coherence and agreement across the project outcomes and the current debate on the status of agricultural water use in the Mediterranean.

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[9] Brussels, 25-26 September 2000

In order to focus the discussion and to familiarise the participants with each other's work background notes (Kroll, A. ed. 2001) were elaborated through a series of exchanges between participants. Each participant was requested to provide a position paper to be discussed at the workshop. This method proved to be highly rewarding since all participants had exchanged views prior to the workshop. The Notes were organised according to the workshop' structure, that is around *three roundtables*:

1. Multi-interdisciplinary research in the context of natural resources and policy analysis
2. Patterns of water used by agriculture and policy development: the issues in the Mediterranean
3. Points to consider for future research

Another positive outcome of the workshop was the funding of a new project, *A Future for the Dead Sea Basin: Options for a More Sustainable Water Management*, under the INCO Programme 2002[10] by workshop participants who had not met before.

The workshop was an interesting opportunity for EU decision-makers to understand what are the research priorities as perceived by researchers working in the area of water and agriculture management (representatives from DG Research, DG Environment and DG External Relations, MEDA programme attended the workshop).

Multi-interdisciplinary research in the context of natural resources and policy analysis

A central aim of this workshop was to discuss the role of multi-interdisciplinary research in water resource management and policy in general and in the Mediterranean context in particular. Multi-interdisciplinarity is often claimed to be an approach used by practitioners but it has seldom been clearly defined. The workshop came up with the following "working definition" that separates out multidisciplinarity from interdisciplinarity. Multidisciplinarity involves "several studies each carried out according to the rules and methodologies of its own discipline, in parallel with all the others"[11]. Interdisciplinarity "involves first the elaboration of a common methodology that would cut across the boundaries of many disciplines". Although the multidisciplinary approach can be performed without too much communication within a team, the results may not be coherent. The interdisciplinary approach requires mutual understanding and trust before the onset of the research itself.

It would seem that it is the interdisciplinary approach that would be preferred, as according to our working definition it connotes true co-operation among researchers.

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[10] *A future for the Dea Sea Basin: Options for a more sustainable water management* (INCO- ICA3-2002-20012). Leading partners met during the POLAGWAT workshop are: R. Orthofer (ARCS, Seibersdorf Research), J.Trottier (Univ. of Newcastle, UK) and C.Lipchin (Arava Institue, Israel). The focus of the project, which is to establish the basis for a "more sustainable than today" water management and water-related land management in the Dead Sea basin takes an interdisciplinary look in terms of both methodology and research partners. Researchers include an engineer, political scientist, environmental lawyer and an ecologist.

[11] Trottier

Yet a fundamental stumbling block exists. This is the difficulty in communicating across disciplines and between experts and “non-experts”. A method is needed to allow people working with different paradigms and using a different vocabulary to understand one another so as to produce a single, coherent piece of work leading to practical recommendations in policy making. The prospective approach discussed in chapter 5 is one way of addressing these issues.

Addressing Interdisciplinary Research

Project teams can consist of both “hard” (primarily engineers) and “soft” scientists (political scientists, sociologists). Usually, “hard” scientists, particularly engineers, and their representatives enjoy the highest level of consideration by policy makers. This consideration and level of power rapidly decreases from the “hard” sciences to the social sciences, and from economists to sociologists and ecologists (usually not considered as a “hard” science by policy makers). Moreover, the views of so-called “non-experts” are often discriminated against or ignored by the bulk of “experts” and policy workers[12]. These “non-experts”, who may be NGOs or indigenous peoples or the public, in many cases possess a greater understanding of a system than scientists. However, because of their non-western conventions they have less influence than currently accepted Euro-centric scientific approaches.

Methodology is also subject to a gradient of consideration. Qualitative methods are considered less important than quantitative ones since, in many cases, where no numbers are presented, there is little trust. This may drive interdisciplinary researchers to adopt quantitative methods from the “hard” sciences, even if they are not the most appropriate analytical tool.[13]

One reason for the greater influence of the “hard” sciences on policy making is its ability to provide immediate solutions to a problem. For example, building a dam can alleviate water-shortages or provide new arable land. This works in the short-term but discounts the longer term effects of such a project such as the alteration of a river system leading to declining fish stocks that then impacts on the livelihoods of local fishermen. These longer term effects are normally encountered only after a decision has been made based on only the short-term benefits. Overcoming such short-term decision-making is difficult because policy makers themselves are in power for protracted periods of time determined by elections.

Differences in scales, levels of analysis, “traditions”, research strategies, intents, and methodologies are all factors impeding a meaningful comparison of results unless acareful and adequate design of an integrative interdisciplinary approach is attempted. In addition, the choice of a multi versus interdisciplinary approach as defined earlier, will directly depend on the objectives of the study. As also mentioned earlier, policy makers tend to prefer the multidisciplinary approach as it allows for unequivocal recommendation, while the interdisciplinary approach can lead to “nuanced

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[12] Kroll
[13] Trottier

recommendations".[14] These may be difficult to translate into policy terms but in many cases are better for teasing apart the complexities inherent in the system under study.

Complexities exist in the interaction of physical and social systems. Traditionally, the object of study has been a component of the physical system e.g.: a river or aquifer. This component is then modified and applied to the social system. Such forced integration can lead to problems, especially when the social system has been excluded from the study. Including the social system would require, among others, an analysis of human behaviour. This is particularly true if behaviour is regarded by policy analysis as something to be changed so to produce a certain kind of reaction towards, for instance, the use of a natural resource (e.g. using water for irrigation). This is the prevailing attitude of policy makers and engineers. Yet the outcome can be unexpected if social systems are not included in the analysis. Thus, indigenous farmers may not adopt new irrigation technologies.

The scales of analysis also need to be determined before the research starts. At the local level, socio-cultural factors are most evident. Economic and engineering approaches normally operate at the national level whereas ecology operates at the regional level (e.g.: watershed and ecosystem approaches). A non-interdisciplinary approach normally focuses on the national level but without considering the local and regional levels that serve to prop up the national level, the national level may collapse.

The difficulty of interdisciplinary approaches in research projects is related to the difference in analytical scales in time as well as in space.[15] For instance, it was recognized in the Cameleo[16] project that since climatic events, agricultural practices, and desertification phenomena occur at different time scales, a minimum common time frame had to be agreed upon by all disciplines involved.[17] Practical solutions may also involve the choice of a common sampling frame. A unit of surface that is impacted by a certain use from a given sub- population (e.g.: the Cameleo project) Can be used as a common object of study In the Imarom project, the agricultural plot was chosen as a common unit of research.[18]

An important distinction in interdisciplinary work is that of research strategies versus research intents. Quantitative approaches focus largely on strategies whereas qualitative approaches focus more on intent. These approaches derive from different research traditions i.e. deliverables that produce numbers as opposed to those that produce attitudes and perceptions. The variability in research methods therefore may widen the communication gap among researchers.

Another difficulty for interdisciplinary approaches is the integration of results and data from various disciplines due to a lack of shared analytical tools. Interdisciplinarity in

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[14] Trottier

[15] de Haas, Trottier and Escadafal

[16] CAMELEO project: http//www.egeo.sai.jrc.it/cameleo

[17] Escadafal

[18] IMAROM project: *Migration, agricultural transformations and natural resource exploitation in the oases of Morocco and Tunisia*. Project funded by the EC, INCO-DC (IC18-CT97-0134). de Haas

this sense should be considered as a new discipline in itself, characterized by shared languages and methods drawn from existing disciplines. Needless to say, this is easier said than done. One may consider the translation and organization of empirical data into a body of knowledge, in terms of the information "making sense" and of being "useful" for the target it is being applied to (reference to theories from Kuhn, Habermas, Benjamin for instance). The data thus collected through an interdisciplinary approach has to be reorganized and processed from various paradigms so as to produce a new body of knowledge. Consider for example, irrigated systems operating as complex integrated systems.[19] Here, the adaptability of the system depends on norms and rules governed by the interactions between physical and social systems. Modifying the internal functioning of both an existing irrigation system and of donor irrigation policies implies participatory tools designed and used in complete integration with the physical and social components (i.e., physical system: hydrology and the social system: irrigation users). Using participatory methods in assessing the viability of an irrigation plan includes physical, economic, social and institutional parameters (see for example: Participatory Irrigation Management by Herzenni – in Kroll, A. 2001 Background notes). Too often, however, users have to adapt to the technical side of a project and not the other way round. This again raises the issue of power differentials between disciplines and social actors.

Ecology probably serves as the most likely discipline for integrating knowledge for interdisciplinary work. This is because its scope is both physical and social as it seeks to understand how organisms, including humans, interact with their environment. This interaction is seen as bi-directional. How does ecology apply in policy analysis where the aim is to get people to behave in accordance with certain decisions, for example: conserving natural resources? This requires understanding human impact on the environment in terms of the way people behave toward it. Thus behavioural research is necessary.

From an analytical point of view, the behavioural component can be considered as either an independent or a dependent variable. If behaviour is considered as an independent variable, then we need to study o why people do what they do in a specific manner (e.g., why do they use a particular quantity of water for irrigation purposes, how do patterns of co-operation and conflict result in specific patterns of resource use?). Considering behaviour as a dependent variable implies the analysis of why people behave in a certain manner given physical constraints. For example: physical water scarcity provides limited options for irrigation and results in the adoption of pastoral lifestyles rather than sedentary ones. From a policy point of view, if behaviour is treated as something to be changed in order to produce sustainable practices, it is a matter of predicting how institutional constraints (i.e.; the social system: norms, market regulations) will produce a certain type of behaviour in a particular environment i.e.: the physical system. This naturally implies defining the criteria of the analysis according to both the physical and social systems and the interaction between the two. Here the notion of interest (or vested interest) of the researcher or policy maker is fundamental. For example, technical

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[19] Mathieu

solutions may be favoured not because they are appropriate in an ecological setting but rather because of control by certain social groups of the resource in question.

In the context of an interdisciplinary research project therefore, we need to consider those people that exert power and influence over a project. They are likely to acquire the power to affect the outcome of the research and may choose technical solutions compatible with the interests of the social group they represent. In order to avoid this kind of hegemony, we suggest the combination of two types of institutional settings for research 1) fundamental interdisciplinary research (i.e. the study of the consequences of policies) and 2) research involving the direct participation of state representatives.[20] This is particularly important in countries where the holders of key positions in universities and research centres were appointed more from political considerations than by technical competence.

This view is endorsed by Dron[21] who suggests that the analysis should be divided into sharing 1) knowledge (e.g., what is the effect of a particular parasite on a particular plant), 2) mutual recognition ("reconnaissance") by experts of the validity of methods that provide comparable results, 3) hierarchicisation of priorities outlined by the various disciplines (e.g., is it more efficient to provide for conditions that allow for easy and controlled access to water resources, or to optimise water withdrawals depending on geographical and seasonal parameters?), and 4) management of socio-economic situations (e.g. to inform the wealthy irrigators first on best irrigation technologies as this seems to be the quickest way to encourage their adoption by the poorest). Dron also notes that each discipline will tend to consider as prime factors those that it is most familiar with.

Recommendations

- The choice of a multi versus interdisciplinary approach will depend on the objectives of the study. From the above discussion, policy makers tend to prefer the multidisciplinary approach as it allows for unequivocal recommendation, while the interdisciplinary approach will lead to nuanced recommendations that can be difficult to translate into policy terms.

- Preparation of the project and choice of partners should ideally be carried out by people that already know one another although interdisciplinarity rests on the forging of new partnerships. Coordination before the start of the project is necessary to justify and determine the choice of the multi-interdisciplinary approach since the multi-inter approach may not always be beneficial to a project. In other words, interdisciplinary research should not be just a matter of convenience for researchers to work together. The working relationship must be able to demonstrate clear and relevant crosscutting objectives for collaborative research.

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[20] Antonius

[21] Personal communication to Kroll (April 2001)

- It is necessary to define a common object of study and methodology, or an agreed set of methodologies that can be integrated, or, at the very least, a common temporal or spatial sample unit.

- Communication channels between project members must be agreed upon. The attitude of the researchers should be flexible, open, with a strong but communicative leadership.

- Whether or not to involve decision and policy makers should be decided before the onset of a project. If they are involved, they may influence the course of the research because of political and/or power relationships. Ideally they should not be involved in fundamental research but can be involved in applied policy analysis that is an outcome of such research in the form of advisory and stakeholder groups.

- The involvement of "non-experts" at an equal level with "experts" in a project must be considered, especially where the outcome of a project will have clear affects on stakeholders. The role of "experts" should be devoted to the validation of knowledge, demonstrate the capacity to integrate uncertainty, and display the ability to build scenarios related to an uncertain future. Of course, this assumes that "experts" are irreproachable, ideologically neutral, not pressured by business, and that their goal is to determine areas of ignorance so as to produce an objective image of complexity.

The successes and failures of POLAGWAT are closely linked to the extent to which these retrospective guidelines were followed.

Patterns of water used by agriculture and policy development: issues in the Mediterranean

A central question to understanding patterns of water use in the Mediterranean countries is: how do water resources and land ownership patterns affect the squantity and quality of a resource, its use, and environmental impact. Patterns of use depend on the impact of socio-economic and institutional effects on agricultural practices, which are themselves influenced by their physical environment.

Institutional arrangements include rules and regulations (including the economic rules of the market and environmental laws) and the organisational structures of control including patterns of ownership and control of resources (essentially land and water). Policy aims to make changes in the institutional framework in order to produce desired outcomes such as environmental benefits and sustainability (positivistic outcome) or, in some cases, the allocation of water to favoured sectors (vested interest outcome). It is important to assess whether the desirable outcomes involve changes to institutional and organisational structures and how institutions and organisations are addressed or affected by policy. In addition, we recognise that behavioural actions could be encouraged, allowed, merely tolerated, discouraged, or prohibited by organisational structures.
Participants at the workshop proposed the following points for addressing the above issues:

- Track changes in institutional settings that define access to and use of land and water resources, and identify the active agents pressing for change.[22]

- Address the issue of how water rights, prices and incentives for efficient use are allocated, used, and how policy makers and users perceive them alike (particularly in relation to land rights and use).[23]

- Examine the interaction between community and the state's apparatus on water issues, in particular, the control of the resource and the degree of voluntary participation by the local community and the modes of control and appropriation by state bureaucracies of community decision-making power.[24]

- Study how the knowledge of collective water management problems can be established and shared; analyse the local functioning of collective water management; and link the actors with the modes of management.[25]

- Aim to establish the "working rules" that regulate local water management, *sensu* E. Ostrom. For this purpose, both the property regimes governing water and their historical origin have to be identified.[26]

- Address the nature of conflicts around water use (e.g. socio-economic conflicts caused by the limitations in wetland/water use imposed by protective environmental laws, which are seen by certain stakeholders as an obstacle to economic development.[27]

- Develop and test the techniques for measuring the status of the environment (ecological quality, environmental threats, regulatory and management responses) in wetlands, and their transposition among different regions of the Mediterranean.[28]

- Establish how the economic and social relationships among the local rural society (with its farmers' groups and its statutory disparities), the market (with its different agents upstream and downstream of agricultural production) and local services of the public administration (some of which are linked to a national political power, and others to local political forces) affect policy implementation and/or the administration of water use.[29]

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[22] Bromley
[23] Vos
[24] Ruf
[25] Ruf
[26] Trottier
[27] Viñals
[28] Viñals
[29] Ruf

- Explain the modes of the disengagement of the state, where this is seen to occur, with its move towards different forms of exercising power, such as a decrease in authority.[30]

Assessing Institutional/Organisational Factors

The following framework can help organise research into patterns of resource use from an institutional or organisational perspective:

1. Description. We can first identify questions and issues that deal directly with the description of each of the three conceptual domains: institutions, behaviour, and outcomes.

2. Causal analysis. A second set of research questions is causal or explanatory. Such questions aim at determining for example, how institutions shape behaviour, and how behaviour determines outcomes.

3. Meta-explanation. A third set of questions can be posed at a higher level of analysis. They deal with the processes that induce the various actors to initiate policy changes (if they are in a position to do so) or to demand policy changes. This scheme also leads to questions on whether or not these higher-level questions are exclusively related to the effect of actors on policies.[31]

4. Development of policy. The final stage involves an integration of the previous three points. Policy orientations must be determined by normative goals justified and supported by descriptive analyses of concrete situations (1) and by reference to the network of causal relationships that have been established (2), and to the theories of new outcomes (3).

Patterns of Conflict

The notion of conflict was also central to the discussions. According to Bromley, conflicts should be seen as competition between stakeholders. They should therefore not be conceptualised as dyads, but as triads. There is always an authority, e.g. the State, that plays a part in the conflict. But, as Trottier's research in the West Bank has exemplified, conflicts in water communities are often intricate, secret, and almost intimate. This is because they involve a broad set of relationships that extend far beyond

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[30] Ruf
[31] Santamaría
[32] Bromley
[33] Vos
[34] Ruf
[35] Ruf
[36] Trottier
[37] Viñals
[38] Viñals
[39] Ruf
[40] Ruf

water or even agriculture. Many aspects of the conflicts are not obvious. This is even more important in cultures where indirect, non-verbal and non-explicit signs are part of the language, for example water ownership in the Jordan valley. The consequence of this state of affairs is that constricted research schedules are counter-productive.

There is a need to distinguish between competition among *users* and competition among *uses*. The two types of distinctions may coincide or not, and they may be explicit or not. Decisions about priorities in *uses* may result in advantages among *users*. While the confusion is sometimes unintended, it is also one of the possible strategies of competition among users who have a differential advantage when there is a shift in the use of a natural resource, such as the allocation of water from agriculture to industry.

In addition, an analysis is needed to identify how technological conditions which help to establish priorities for the use of a resource end up establishing differential advantages among its users, for example drip irrigation systems that work well for certain crops but not for others thus favouring some farmers over others. This situation raises questions about the way in which we can establish scientific criteria for determining optimal resource use, when any decision about prioritising uses is also a decision (often implicit) about giving advantages to certain categories of users. This also explains why the evaluation of water-use efficiency can result in conflicting scientific criteria.

Conclusions

To overcome the problems in the development of criteria for evaluating water-use efficiency, the various competitors for water, water use and water access have to be established. The relations between the local actors, between them and the national government, and between them and international actors should also be identified. Although this identification of what is at stake among users and uses will not result directly in objective criteria for resource use, it may point to how the interests of some categories of users are linked to the various uses of the resource. In addition, the multiple inter-relationships that link water across a complete river basin should be identified.[41] In this context, complementarity rather than conflict may be sought with different sectors making use of a common water resource (e.g. wetland systems and agricultural systems where the ecosystem benefits of the wetland provide beneficial services to the agricultural land). Complementarity may be achieved by fostering direct negotiation among stakeholders and hands-on work with local users. The competition between apparently conflicting uses of water may be transcended if the lines of distinctions between uses do not coincide with the distinctions between users, i.e. if the same users are in a position to gain from a shift in water use or in the way water uses are integrated.

Recommendations

- Competition, co-operation, communication and negotiation in irrigation communities are items that require interdisciplinary research.

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[41] Santamaría

- Drainage should also be considered as a resource. This can lead to the notion of multi-use of water resources.

- Conflict occurs between individuals, but in many cases these conflicts are framed by the existence of a third actor, the State or its agents. Many aspects of conflict are not obvious unless enough time is devoted to their study.

- Four components of policy can be identified: (1) a perceived failure of the *status quo ante* to give rise to accepted behaviours and outcomes with respect to land and water use; (2) a recognition that existing institutional arrangements are the reasons for particular behaviours that then give rise to the undesired outcomes; (3) a theory that reveals how new institutional arrangements might plausibly induce new behaviours that would solve the perceived problematic outcomes; and (4) a commitment from the state that the new institutional arrangements, once adopted, will be enforced so that new behaviours will result.

- Where there is top-down control, investigate how far it has disempowered local communities, and has devalued their local knowledge, institutions and their modes of control by the appropriation by state bureaucracies of community decision-making power. One of the issues that is related to such disempowerment is the issue of the recognition of traditional rights over natural resources.

- Provide an integrated analysis of the complexity of causes (economic, legal, administrative and social) behind wetland degradation and the ways in which wetlands can provide complementary services for agriculture. This also applies to agricultural land where a history of careful use produces an improvement in its agricultural capacity is followed by uses that result in soil degradation and loss of agricultural capacity.

- Competition, co-operation, communication and negotiation in irrigation communities must be treated as social tools for managing water scarcity. The following key-concepts, which are crucial to understanding how systems work, must play a pivotal role in the holistic analysis of irrigation systems. These are: flexibility, adaptation, design, understanding information quality, long-term strategies, local public participation, and institutionalisation.

- The irrigation system is only one component of the constraints that farmers have to deal with in developing a strategy for their livelihood. A conceptual system for analysing water use must be much broader than the irrigation system itself, especially if this system is state or absentee-landowner driven.

- In a peasant society, the criteria of *security* often provides a better explanation of behaviour than the concept of *efficiency in water use*, and security is determined and guaranteed outside the irrigation system itself. Because of this articulation, even large systems may operate as a result of negotiations that occur at the local level.

- The question of why and not just how to intervene (analysis of the objectives of policies) must be asked when discussing policy options.
- The patterns of distribution of the resource as much as the total quantity, is crucial in understanding how systems work and thus in developing policies.
- Because human factors are much more complicated to incorporate in modelling than natural resource subsystems, every model has limits that must be identified clearly. This is inherent in modelling exercises associated with uncertainty due to the high level of untested interactions
- The differential access to power among individuals and groups must be incorporated explicitly in models attempting to explain and predict behaviour in natural resource use. There is presently a lack of modelling frameworks which can deal with this issue.
- The interaction between the predictions of physical sciences and the effect of management options must be explicitly acknowledged and addressed. Physical sciences can predict scarcity and shortage. However, management can change the amounts that are actually available within bounds that must be clearly identified.
- Finally, the *precautionary principle*, including the notions of *risk* and of *responsibility*, must be taken seriously when it comes to the design of policies and their transformation into regulations for the use of natural resources.

Points to consider for future research

The focal point of the discussions was the path to be taken toward sustainable water use in the Mediterranean. The path from unsustainable to sustainable water use is not a direct one and involves many factors. The perception of unsustainability is influenced by physical, political and social factors () interacting in complex ways.

Supply and demand

As mentioned earlier, there are two responses to water shortage. The first response is primarily to develop policies that support supply augmentation such as exploiting new water resources or technological considerations such as desalination. The second response is to introduce demand management policies that emphasise making more efficient use of water.

It is clear that some traditional systems of irrigation management have worked well and are sustainable although this does not necessarily mean that they are efficient users of water, especially if these systems are maintained by economic rather than ecological systems. However, longer-term sustainability depends *inter alia* on control over water allocation remaining at a local level, the system not being over-intensified and the water resource base not being depleted. These conditions all depend on outside pressures, particularly those exerted by the globalisation of economies.

The discussions supported the conclusions of chapter 5 on the difficulties of implementing demand management. Many large-scale irrigation projects have been implemented on the basis of concerns about supply to the detriment of water resources and to the local users of the resources. Many of these projects make subsequent demand management difficult to implement. For example, the creation of the National Water Carrier by Israel diverted water from the Sea of Galilee to the arid Negev in the south for irrigation. The water carrier has severely affected the flow of the Jordan River, and its existence, together with heavy price subsidies, has resulted in the adoption of agricultural and irrigation practices unsuitable to the arid conditions of the Negev that are now difficult to change.

However, water scarcity may sometimes not be physical at all but rather a phenomenon created by political and social factors. It has thus both a physical reality and a socially constructed aspect through costs, ownership, traditional use and knowledge. When there is perceived to be a scarcity of water, there will be pressure to either increase the available water resources or to conserve water. This either-or relationship formed the crux of our discussions. For in reality, concentrating on one process at the expense of the other leads to projects that at best are temporary solutions. Sustainable water use depends on the convergence of these two processes.

Points to Consider for Future Research

Water resources can be increased by transferring water from areas of excess water to areas of shortage. Any such transfers of surface water will have an effect on the region from which the water is taken, as in the example of the Israeli National Water Carrier mentioned above. Long distance transfer of water often also incurs considerable transport losses. These losses can be from leaking pipes, seepage from canals or evaporation from water surfaces. Although there are technical solutions to these problems, they are often costly. Increased abstraction of groundwater is only sustainable if the recharge rate is not exceeded. Water resources for agriculture can also be reduced due to competition from domestic and industrial consumers.

Rather a lot is known about the technical aspects of water use efficiency although there appear to be no formalized benchmarks against which performance can be compared. Some types of irrigation, such as drip irrigation, have potentially very high efficiencies but they are not suitable for all crops. Socially constructed concerns are also important here, such as health and moral concerns. The development of new technologies such as wastewater re-use may run counter to religious beliefs of indigenous peoples on the sanctity of water and render them unacceptable for such communities, despite acute water shortages. Low cost and low-technology options such as rainwater harvesting, as implemented by the Nabateans more than two millennia ago in the Negev desert, should not be dismissed or over-looked as potential measures for water efficiency in developed regions. It is not inconceivable that the flow of knowledge from less developed to more developed regions may prove more sustainable than the other way around. There is thus a need for training and dissemination of best practice methods both locally and internationally and from both developed and less developed regions.

The amount of water available is not the only issue of concern as water quality can be of crucial importance. Some crops can be irrigated with weakly saline or other non-potable water while others require high quality water. For the former, one way of increasing effective water resources is by recycling water. There are now a number of places in the Mediterranean basin where water is re-used for irrigation after domestic use. This practice will be most effective where the water requires little treatment and where the water is available close to where it is needed for irrigation. But as mentioned above, this also requires social acceptance. Perceptions therefore by the end-user cannot be ignored and must be integrated into any feasibility study of such options.

Irrigated systems are not necessarily the best throughout the Mediterranean area. Rainfed systems have traditionally been important and may be more sustainable where there is adequate winter rainfall. Although such systems may receive supplementary irrigation, the conditions when water is most needed for crop survival are exactly those when water is least available for irrigation. Changes in the rainfall pattern or amount could have profound effects on the viability of such systems. Predictability of rainfall is important for these systems, as crops and cultivars can be chosen to make the best use of the rainfall and soil water. The consequences of the adoption of new agricultural systems in a particular location need to be predicted if a rational decision is to be made about their sustainability. Such decisions will require the both physical and social systems to be considered. For example, a shift from dryland to irrigated agriculture or *vice versa* would have a large effect on water use requirements and social structure.

In most countries, water is subsidised both in terms of capital costs and running costs. This is clearly a barrier to free trade and true trade liberalization will ultimately require farmers to pay the real cost of water. Charging farmers the true costs of water would have a very large effect on Mediterranean agriculture with consequent knock-on effects on other sectors of the economy. However, it is by no means clear what is the most equitable basis for water pricing. Government protectionism and support for maintaining self-sufficiency in agriculture is especially problematic in the Middle East region. The energy costs associated with the export of Mediterranean produce can also be high and any increase in transport costs due to increased oil prices or a climate change levy will reduce the capacity of farmers to pay increased water charges. It is important to research the effect of water conservation policies such as pricing for particular circumstances.

If irrigation is not managed effectively there can be adverse environmental effects both in terms of pollution and losses of biodiversity (although irrigated agriculture can be beneficial for biodiversity). Pollution does not necessarily only impact on the farms carrying out the irrigation but can have effects at a distance by contaminating surface or ground water.

In some parts of the Mediterranean basin, demand for meat products has resulted in an increase in livestock husbandry. This increases the demand for water, as it is needed to produce animal feed, for drinking by the livestock and for processing. Unless the feed is imported, the production of food energy or protein per m^3 of water is much lower from livestock than from crops.

Effective policy making and implementation depends on an appropriate legal and institutional framework. Such a framework should take account of local conditions by involving local users in an interactive and inclusive manner so that the real problems can be identified and appropriate solutions found. There is debate as to whether negotiations between providers and users of water should begin before or after problems arise. Polarising such communication as "top down" or "bottom up" oversimplifies the situation as effective discussion often follows an iterative procedure with information flowing in both directions. Effective ways need to be found to combine the indigenous knowledge of irrigators with scientific knowledge and to disseminate the results. Water policies do not only affect farmers in the targeted regions. Scale, level of technology employed and infrastructure are all policy outcomes with the potential of impact elsewhere.

Trans-boundary concerns also need to be taken account of particularly in Iberia and the Middle East. There is a need to develop regional institutions that are jointly governed by those states sharing a water resource. The management of the River Danube could act as one model of how this could be done.

Policymaking and implementation also require data to be collected to an appropriate standard of accuracy and scale. It is clear that there is considerable spatial variability in soils, climate and farming systems and that these influence the effectiveness of policies in achieving the desired objectives. Information systems need to be implemented at an appropriate scale so that indicators of performance can be estimated and action taken to remedy poor performance. Scale is important in relation to irrigation because of the difference between the consequences of an individual's decision making and that of a whole community of irrigators. It is often taken as axiomatic that policy implementation should be at a catchment scale and this means that information will have to be shared between administrative units, in some cases across political boundaries. However, there are circumstances where social institutions cross catchment boundaries and some social scientists feel that the catchment scale is not necessarily the most important one. Farmers using irrigation also need information systems but their needs are different from those of policy makers.

Conclusions

It is clear from the contributions to this workshop that the patterns of resource use, land ownership and other socio-economic factors that were the focus of many of the discussions are of critical importance in explaining the success of policies that achieve better use of water in agriculture. Sustainable water use is consequently dependent on an interactive and integrative process that cuts across levels of influence and knowledge and recognises the importance of monitoring, communication and power structures. To move towards sustainable water use we need to take account of institutional processes, prices, trade, technology and the way in which water as a resource itself is perceived. The evolution of perceptions of how water is used and whether or not it is scarce is therefore dependent on reconciling qualitative and quantitative approaches to research and policy making.

Recommendations

- Interdisciplinary projects should seek to involve local users. This will lead to a better identification of problem identification and response.

- “Top down”and “bottom up” approaches are oversimplifications. Rather, projects should acknowledge and address complexity and variability that are inherent in all systems.

- The phenomenon of water scarcity can be either socially constructed or physically constructed and this needs to be considered when designing projects.

- Conditions for water conservation behaviour (legal and institutional, scale, technology and infrastructure) are all policy outcomes and thus have potential for impact.

- Information from stakeholders, scientists, engineers and social scientists should be integrated with indigenous knowledge and made available.

Chapter 7

7. GENERAL CONCLUSIONS

Public opinion usually associates the Mediterranean with water shortages and warm and dry summers. Scarce and unevenly distributed over time and space, water is intricately linked to the socio-economic development of the Mediterranean countries where the water demand is typically higher than available supply. The greatest demand for water in the Mediterranean countries comes from the agricultural sector, which accounts for more than 80% of water withdrawal. The only way to balance supply and demand is therefore to decrease the demand in one or more sectors. Reducing the use of water in the agricultural sector does not necessarily means reducing the agricultural sector. Since agriculture is the very basis of the social, economic and cultural identity of many regions of the Mediterranean, it has no incentive to disappear. However, with increasing demands for water from other sectors, in particular when the specific pattern of seasonal demand from the agricultural sector conflicts with other uses, these countries are in a difficult position and some of them have started to address the issue.

To reduce the amount of water needed in agriculture, a variety of technical and engineering options exist. These include the use of more efficient irrigation technologies, the adoption of farming systems that conserve water, and the decision to plant crops with lower water needs such as naturally adapted ones. However, in most areas, farmers do not implement these options as they are influenced by other factors. Typically, the determining factor is government policy in sectors that are sometimes far removed from water management. If the governments are aware of the problems linked to the water resources, most of the time, their response is an engineering solution to increase water supply, e.g., building dams. Less frequently, will water managers consider options such as water re-use, water pricing or other policies. In any case, whether from the supply or demand side, the options will rarely step out of the "water sector" which manages capture, storage and supply of water to users. However, policies in other sectors may have an equally strong impact on the farmers' decisions to reduce water use and have received up to now little attention. Understanding the relationships between sectoral policies and the use of water in the agricultural sector was precisely the main objective of project POLAGWAT.

Policies affecting agricultural water use

The descriptive studies of the individual countries have shown that a wide range of policy factors influences the use of water in agriculture. The six countries examined showed differences in terms of land ownership, control over water resources, availability of groundwater, rainfall amount and reliability and degree of intensity of agriculture and its market orientation. Although influences on the exploitation of water resources are mainly external (e.g., trans-boundary issues, the global economy), the way these issues are dealt with depends on the political and socio-economic situation in each country. This is also true of data collection where data unavailability and the lack of standardised methods between countries, within a country, and from year to year were noted. Surprisingly large discrepancies were noted between international data sets, such as the ones of FAO, EC databases, ICID, and the national sources used in the national case studies even though the former are often derived from the latter.

Although the amount and quality of available information varied considerably, the state of irrigated agriculture in each country was assessed. An overall situation for the Mediterranean countries could not be drawn due to the differences mentioned above. However, it can be said that in countries like Egypt and Israel, almost all the resources are used completely and any expansion now depends on using water more efficiently and re-cycling wastewater. In Israel, any progress will have to come from changing to crops that make better use of water or using naturally adapted crops since the most efficient irrigation schemes are close to their theoretical maximum efficiency. In other countries, there is scope for increasing the efficiency of water use considerably. This, however, does not necessarily mean changing the irrigation technologies, as maintenance of distribution networks, monitoring water used and training of farmers and technicians also provide opportunities to save water. A major issue is the price of water and how it will affect the agriculture sector as in most countries, and in particular in the MENA countries, no charge is levied for water withdrawals. Irrigated water use is not priced and the right of use is associated with land ownership patterns which vary across countries.

An important part of the project assessed the impact of agricultural policies and other sectoral policies on the use of the water resources. The agricultural policies of EU and MENA countries are clearly different. While EU countries have to fit into the framework of the CAP, MENA countries are not subject to a single, uniform agricultural policy. MENA countries are typically more concerned by objectives of food-security and food self-sufficiency and the associated increase in agricultural production, while EU countries are subject to opposed forces, one driven by agricultural production and the other by diminishing agricultural surpluses. Today, agriculture in Mediterranean Europe has one dominant economic issue: agricultural emigration.

In the European Mediterranean countries, there is a marked decrease in irrigated expansion. Historical developments in irrigation technology and the availability of irrigation water are the key factors that have shaped the present status of irrigation in each country. No substantial new development of irrigated areas is foreseen in Spain, Italy and Israel. The case of Spain is remarkable since it has experienced a period of tremendous expansion in irrigation between 1950 and 1980, which doubled the total irrigated area in less than 30 years. However, the development of publicly funded new irrigation schemes has sharply decreased since Spain joined the EC in 1985. The slowdown in the rate of expansion of irrigation in Italy and Spain is also related to the higher costs of adding irrigation capacity since the best sites have already been developed, and to the growing public concern about environmental issues. This phenomenon seems to be world-wide. In fact, agricultural policy in the Mediterranean is gradually shifting towards rural development policies aimed at diversifying activities in rural areas, a way to recognise the multifunctional role of agriculture.

Other relevant policies include regional development (national and major donor policies for non EU Member States), land use planning, other economic sectors (tourism, industry) and environmental policies (water policies, biodiversity, habitat protection). For instance, irrigation development can occur as a side-effect of energy policies, as in oil-dependent Turkey which is developing hydro-electric rather than nuclear energy with a very significant dam-building programme. The water impounded will also be used for irrigation.

In EU countries, where the situation is much easier to delineate since Community legislation is the rule, the main driving forces are: the new European water policy, the new orientations of CAP under Agenda 2000 and the regional/national policies enforced in EU Objective 1 regions supported by the structural and cohesion funds. Water quantity objectives, which could directly affect agricultural policies are not within the scope of the EU Water Framework Directive. Its main affect will be through the promotion of water management according to river basins. Therefore, water quantity objectives will remain the responsibility of Member States, mainly through their agricultural policies.

While there is no generalised conflict between water use for irrigation and other sectors (except in some regions where there is a clear competition for water resources), conflicts for water resources are expected to increase in intensity and in frequency between the tourism and agricultural sectors, especially with irrigated agriculture. Reallocation of water from agriculture may result in a great increase of water supply for other sectors. When agriculture represents 90% of national water consumption, a 5% water saving in agricultural water demand provides a 50% increase of water supply for other sectors.

From the above, it can be said that irrigation systems are only sustainable when water of adequate quality is available at the right time and in sufficient quality, the system is profitable to the farmers and negative impacts on the environment are tolerable both in terms of international obligations and acceptability to other stakeholders.

Facing water scarcity: obstacles to shift from supply to water demand management

In Mediterranean countries, the existing water policy for irrigation is based on subsidies and users have little or no incentives to decrease the demand (except in Israel where the use of wastewater is promoted). In practice, high priority is given by responsible authorities to increasing water supply through new projects, while financial resources remain limited for the implementation of techniques using less water and rehabilitation projects. Overall, in the countries examined, except for Israel, at least 60% of the water conveyed through surface irrigation network never reaches the crops. In MENA countries, enhancing supply to permit agricultural expansion driven by food self-sufficiency concerns has been the major water management approach. In EU countries, decentralisation and river basin management are the preferred options. At present, the drastic depletion of water resources in most Mediterranean countries confirmed by various performance indicators reveals that demand management must be the guiding principle. However, the obstacles to the implementation of demand management policies are very significant: socio-political acceptability of preventive demand management measures; national political choices preventing demand management at a regional scale; power relationships within the planning process.

Demand management scenarios were investigated by adapting scenarios contained in the national planning documents. The sample of countries selected represented diverse planning regimes, from consistent technocratic planning to autonomous regions and participatory planning processes. The organisation and process of water policy and planning are important elements in the feasibility of demand management. A meaningful output from this work turned out not to be the scenarios themselves but the experience in implementing the methodology in a wide range of circumstances since the methodology focuses on the balance between demand and supply. The analysis showed that planned irrigation development usually follows the most optimistic scenario of agricultural water use.

From the analysis of planning documents and exchanges with water and agricultural decision-makers of the examined countries, two situations emerged. In cases where only a small proportion of renewable water resources are utilised, demand management is often not seen as necessary since water savings have only a small impact on the exploitation index (referred as first situation). Increasing the efficiency of the agricultural water use is best tackled by ensuring that the performance of new hydraulic projects is high. In other situations, a very high proportion of the renewable water resources is already mobilised, and further mobilisation of water will be increasingly problematic (second situation). In this case, reallocation of water between sectors should be considered (like in Israel). Regional differences have also to be considered since the same country may face both situations (Northern Turkey is in the first situation and South Western Turkey in the second).

Over time, countries move from the first to the second situation. In the second situation, where natural renewable water resources that can still be mobilised become scarce, a choice has to be made, between implementing pre-emptive demand management measures or continuing the mobilisation of the resources at the same pace. In each of these cases of water scarcity, the water planner should study demand management opportunities (water savings by sector, efficiency of allocation between sectors) because the overall efficiency of water use has to be taken into account before allocating water from new and costly resources. Questioning the traditional division of water among users is not easy for reasons of socio-political acceptability, usually leading the water manager to prefer technical supply management measures. However, the sustainability, quality and environmental impact of water supply techniques (e.g., water transfers, desalination, non-renewable aquifers, treated wastewater) are still subject to debate and their price evolution is uncertain. The experience of countries like Egypt and Israel in using water coming from treated wastewater will be important for other Mediterranean countries experiencing water scarcity since it leads to control the amount of water available for agriculture. In some Mediterranean countries though, the demographic transition to lower birth rates could ease the transition from exponential to stabilised water demand.

Geopolitical factors and power competition between political institutions for territories were also noted as important factors external to the decisions of the national water and agricultural policy makers. These factors can sometimes be more important than water efficiency and can prevent demand management measures from being implemented.

Future agricultural water use may be directly linked to water scarcity, or indirectly to the impact of national or regional policy decisions. However, other important factors also influence future agricultural use and include the future market prices for agricultural produce, the Euro-Mediterranean partnership negotiations, the free-trade zone agreements, the EU Directives on agriculture and environment, the donor policies on funding hydraulic and agricultural projects and climate change. In this context, the question is how to make the irrigation sector resistant to market changes and water scarcity. A more general discussion on demand management should reflect on the efficiency of the allocation of water between sectors. The goal should be to move from a situation of preparing the agricultural sector for a possible restriction on its use of water to making the agricultural sector more adaptive to change including water use reduction.

The interdisciplinary approach

Understanding the interactions between the use of natural resources (water, land) by human beings and how their actions are influenced by policies necessarily requires the integration of knowledge from a variety of disciplines. These disciplines include the natural sciences, the technical and engineering sciences on the one hand, and the sociology and political sciences on the other. However, in order to put various disciplines together, it is necessary to carefully integrate beforehand various scales, design, methodology and paradigms across disciplines if the goal is to have meaningful and comparable results. Modalities for project operation are usually not covered in a scientific report., However, since most EU projects are nowadays requested to operate in multi or interdisciplinary mode, it is important to reflect on the experience and benefits of interdisciplinary work in research. These discussions took place during a workshop organised under the project POLAGWAT (Water, Land, Agriculture and Policies in the Mediterranean, Brussels, 19-20/04/01, see Chapter 6).

During the workshop, a working definition that separates multi from interdisciplinarity was made. The interdisciplinarity approach was preferred as it seems to connote true co-operation across disciplines. In many cases, within project teams consisting of both "hard" (primarily engineers) and "soft" scientists (political scientists, sociologists), a power differential exists where the "hard" scientists influence policy-makers over the "soft" scientists. "Hard" scientists have usually greater influence on policy-making as they are able to provide immediate solutions to a problem, comforting the decision-maker into an unequivocal decision. On the other hand, "nuanced" recommendations are transmitted to decision-makers by "soft" scientists who generally focus on the long-term, a scale not always compatible with the decision-making process. Another important issue raised is the unclear involvement of the so-called "non experts" such as the public or water users, in providing recommendations to decision-makers. The "non experts" are generally discriminated against by the experts and policy makers. This gradient of consideration also exist for methodology where qualitative methods are considered "less" valuable than quantitative ones (where there is no number, there is no trust).

Although research strategies versus intents are rarely mentioned, they are important when working with an interdisciplinary approach. Quantitative approaches focus more on strategies, while qualitative ones focus more on intent. The deliverables will produce in one case numbers and in the other attitudes and perceptions. The variability of research methods should be accepted by interdisciplinary teams in order to avoid the communication gap between researchers.

To conclude, interdisciplinarity should perhaps be considered as a new discipline in itself, characterised by shared languages and methods drawn from various disciplines. In this sense, ecology is probably the most likely discipline to integrate knowledge from interdisciplinary work as it its scope is both physical and social/behavioral seeking to understand how organisms interact with their environment. Additionally, the power and influence interactions that exist within an interdisciplinary project should not be ignored. A way to avoid the hegemony from one group is to combine two types of institutional settings for research: 1) fundamental interdisciplinary research (i.e.: the study of the consequences of policies) and 2) research involving the direct participation of state representatives.

Chapter 8

8. RECOMMENDATIONS

The project POLAGWAT has documented the complex interactions between the use of water in agriculture and sectoral policies in the Mediterranean. It was seen that a purely technical solution to lower the amount of water in agriculture was not adequate without considering the impact of agricultural, water and other policies, as well as the socio-economic background conditioning the use of the water resources by farmers. In a context where the water supply oriented management is still prevalent, though no longer available to most Mediterranean countries, solutions involving water demand management measures must be sought.

The present recommendations are drawn from both the project POLAGWAT and the discussions that took place at the resulting workshop (see Chapter 6). At the workshop, it was interesting to note that participants from other projects, disciplines and cultural background validated the conclusions from the project POLAGWAT. Therefore, there was a high degree of agreement between the project outcomes and the current debate on the status of agricultural water use in the Mediterranean. At the workshop, the point discussed was whether or not agricultural water use in the Mediterranean countries is unsustainable, leading to a debate on water scarcity. It was also noted that in arid and semi-arid regions like the Mediterranean the combination of both water and land resources should be considered in policy making.

The following section includes main recommendations on the comparability of data on water and agriculture and the introduction of policy changes towards water demand management. Suggestions for successful interdisciplinary research projects are also made. The last part concerns future lines for research in the area of water resource for agriculture.

Comparing data on water and agriculture

- Water use indicators should be chosen with a clear view of the use of which they are to be put as this affects the intensity, scale and accuracy required. Indicators for monitoring the effect of policy have different requirements from those managing water schemes and should be chosen with this in mind. The criteria for choosing indicators include their consistency over time, sensitivity to change and appropriate scale (in some cases, the overall country figures for indicators are less important than those for key regions). In addition, the interpretation of indicators should be enhanced by ensuring that indicators are independent of each other and that one is not a necessary condition of the other.

- Alternative and practical approaches to resolve data comparability could be the use of indicators with common definitions specifically chosen for the Mediterranean context. The increasing need to have more comprehensive data on water resources and on human water use while the costs of good-quality fieldwork are high should be overcome by using high resolution technologies (telemetry, satellite remote sensing, GIS, simulation modelling). Although derived data should not be used in isolation from measured data, its use could also resolve the problem of unavailability of certain data by making assumptions and deriving values from other available data.

Introducing policy changes to move towards water demand management

- Competition, co-operation, communication and negotiation in irrigation communities as measured through social tools for managing water scarcity are items that require interdisciplinary research. These items must be treated as social tools for managing water scarcity. Moreover, the following key-concepts are crucial for policy-makers to understanding how irrigation systems work. These are: flexibility, adaptation, design, understanding good-quality information, long-term strategies, local public participation, and institutionalisation.

- Drainage should also be considered as a resource. This can lead to the notion of multi-use of water resources.

- The irrigation system is only one component of the constraints experienced by farmers during their livelihood. Therefore, a conceptual system for analysing and managing water use must be made much broader than the irrigation system itself. This raises the methodological and policy issue of the articulation among subsystems, and between subsystems and a global system. Because of this articulation, even large systems may work as a result of negotiations that occur at the local level.

- The question of why to intervene (analysis of the objectives of policies), not just how to intervene must be asked when discussing policy options.

- The question of the patterns of distribution of the resource, not just the total quantities, is crucial in understanding how systems work and to develop policies. This is related to the fair share of costs and benefits within irrigated agriculture.

- The interaction between the predictions of physical sciences and the effect of management options must be explicitly acknowledged and addressed at the policy level. Physical sciences can predict scarcity and shortage. However, management can change the very amounts that are available in the first place. Consequently, the capacity of management to affect the amounts available can only occur within certain bounds that must be clearly identified.

- The *precautionary principle*, including the notions of *risk* and of *responsibility*, must be taken seriously when it comes to the design of policies and their transformation in regulations in the use of natural resources.

- Local users should be involved within interdisciplinary projects. This will lead to a better identification of problem identification and response.

- "Top down" and "bottom up" approaches are oversimplifications. Rather, projects should acknowledge and address complexity and variability that are inherent in all systems.

- The phenomenon of water scarcity can be either socially constructed or physically constructed. Teasing this apart needs to be considered in project design and policy making.

- Conditions for water conservation behaviour (legal and institutional, scale, technology and infrastructure) are all policy outcomes and thus have potentials for impact.

- Integration of information from social actors and dissemination of scientific and "non-expert" knowledge must be made available

- Water pricing policies should be cautiously and gradually implemented, starting with the installation of water meters, then shifting to a price system per volume used rather than per irrigated area, and ultimately recovering an increasingly high proportion of the real costs. Other possibilities to give value to water exist, like to permit selling water rights to other users (from agricultural to urban users for instance). Before any kind of such regulatory measure is put in place, this procedure should be tested beforehand.

- New orientations in major donor policies should take into account the scale issue by sponsoring experimentation and piloting drainage schemes to identify the solution prior embarking onto large-scale irrigation extensions. Along that line, more funding should be devoted to operation and maintenance of existing irrigation systems.

- The policy design should consider various levels (national, regional, basin) at which the policy is operational.

- Participatory planning and policy making schemes should be promoted to involve more the regional level directly affected by the agriculture and water policies. The extent to which all or part of the stakeholders are involved in the policy making process may need also to be considered. Reinforcing the organisation of water users is seen beneficial since it has been observed that low-level management water organisations usually self-governing ones are very effective in using agricultural water.

- Better communication between the agricultural and water sectors should take place, for instance by collaboration between responsible water and agriculture ministries in elaborating agri-environmental indicators specific to the Mediterranean context.

- However, the only solution that is likely to result in real policy change towards demand management is to question the justification of present and past resource development policies in the Mediterranean. Unless this is accepted, practical policy change actually reducing the use of water in the agricultural sector is deemed to fail.

Conditions for interdisciplinary research

- The choice of a multi versus interdisciplinary approach will depend on the objectives of the study. Usually, policy makers tend to prefer the multidisciplinary approach as it allows for unequivocal recommendation, while the interdisciplinary approach will lead to "nuanced" recommendations more difficult to translate into policy terms.

- Preparation of the project and choice of partners should be performed with people that already know one another. However, interdisciplinarity rests on the forging of new partnerships. Before the start of any project it is necessary to first evaluate and justify the choice of the multi-interdisciplinary approach since the multi-inter approach may not always be beneficial. The working relationship must be able to demonstrate clear and relevant crosscutting objectives for collaborative research.

- An integrative interdisciplinary approach should identify the appropriate design scales, levels of analysis, "traditions", intents and research strategies beforehand in order to achieve a meaningful comparison of results. The existing complexities in the interaction between physical and social systems should not be disregarded. When the social system (e.g., analysis of human behaviour) has been excluded from a study where the main component is the physical system (e.g a river basin), forced integration can lead to problems and inaccuracies. Typically, economic and engineering approaches normally operate at the national level whereas ecology operates at the regional level.

- It is necessary to define a common object of study, a common methodology or an agreed upon set of methodologies that can be integrated or at the very least, a common temporal or spatial sample unit.

- Communication patterns among project members must be agreed upon. The attitude of the researchers should be flexible, open, with a strong but communicative leadership.

- Whether or not to involve decision and policy makers should be decided before the onset of a project. If they are involved, they may influence the course of the research because of political and/or power relationships. Ideally they should not be involved in fundamental research but can be involved in applied policy analysis that is an outcome of such research in the form of advisory and stakeholder groups.

- The involvement of “non-experts” at an equal level with “experts” in a project, especially where the outcome of a project will have clear affects on stakeholders must be considered. The role of “experts” should be devoted to the validation of knowledge, demonstrate the capacity to integrate uncertainty, and display the ability to build scenarios related to an uncertain future. Of course, this assumes that "experts" are irreproachable, ideologically neutral, not pressured by business, and that their goal of contribution is to determine areas of ignorance so as to produce an objective image of complexity. A pitfall to this is the hegemony of scientists.

- Competition, co-operation, communication and negotiation in irrigation communities as measured through social tools for managing water scarcity are items that require interdisciplinary research.

Future lines for integrated research in the area of water management, agriculture and policies

- Address the nature of conflicts around water use (e.g. socio-economic conflicts caused by the limitations in wetland/water use imposed by protective environmental laws, which are seen by certain stakeholders as an obstacle to economic development).

- Study the nature of the conflict, , such as the involvement of the State as in many cases conflicts over the water resources are framed by the existence of a triad, that is the State or acting authority.

- Explain the modes of the disengagement of the state, where this is seen to occur, with its move towards different forms of exercising power, such as a decrease in authority

- Investigate the way *top-down* control has dis-empowered some local communities, has devalued their local knowledge and institutions, and their modes of control and the appropriation by state bureaucracies of community decision-making power. One of the issues that are related to such dis-empowerment is the issue of the recognition of traditional rights over natural resources.

- Provide an integrated analysis of the complexity of causes (economic, legal, administrative and social) behind wetland degradation and the ways in which wetlands can provide complementary services for agriculture. This also applies to agricultural land, where there is a history of careful use that produced a valuation of the land followed by a few decades of contemporary use that produced soil degradation and loss of agricultural capacity.

- Investigate the limits of a model, as opposed to the concrete realisation of the model. Human factors are much more complicated to incorporate in modelling than natural resources subsystems, therefore, every model has limits that must be identified clearly (degree of uncertainty).

- Investigate the notion of asymmetry of power among actors. The differential access to power among individuals and groups must be incorporated explicitly in models attempting to explain and predict behaviour in natural resource use. There is presently a lack of modelling frameworks, which can deal with this issue.

- Track changes in institutional settings that define access to and use of land and water resources, and identify the active agents pressing for change.

- Address the issue of how water rights, prices and incentives for efficient use are allocated, used, and how policy makers and users perceive them alike (particularly in relation to land rights and use).

- Examine the interaction between community and the state's apparatus on water issues, in particular, the control of the resource and the degree of voluntary participation by the local community and the modes of control and appropriation by state bureaucracies of community decision-making power.

- Study how the knowledge of collective water management problems can be established and shared; analyse the local functioning of collective water management; and link the actors with the modes of management.

- Aim at understanding the "working rules" that regulate local water management, *sensu* E. Ostrom –for this purpose), both the property regimes governing water and their historical origin have to be identified.

- Develop and test the techniques for measuring the status of the environment (ecological quality, environmental threats, regulatory and management responses) in wetlands, and their transposition among different regions of the Mediterranean.

- Establish how the economic and social relationships among the local rural society (with its farmers' groups and its statutory disparities), the market (with its different agents upstream and downstream of agricultural production) and local services of the public administration (some of which are linked to a national political power, and others to local political forces) affect policy implementation and/or the administration of water use.

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ANNEXE. GLOSSARY OF TERMS

The following definitions are used in the project POLAGWAT. The glossary covers three types of indicators: 1) related to irrigation, 2) water resource commonly accepted concepts, and 3) pressure indicators. Various sources for the compilation of definitions have been used: UNEP/Plan Bleu (Margat and Vallée, 1999), FAO (Irrigation Water Management-Training Manual No.5/Irrigation Methods date? and Yearbook, Vol. 43, 1989), IBRD (A World Bank Policy Paper-Water Resources Management, 1993) and other sources (Trottier, 1999, Tchobanoglous, 1985).

Agricultural water use in % of total water used Different from the water balance

Aquifer: An underground stratum that is saturated with water and transmits water readily.

Arable land refers to land under temporary crops (double-cropped areas are counted only once), temporary meadows for moving or pasture, land under market and kitchen gardens (including cultivation under glass), and land temporarily fallow or lying idle.

Area salinised by irrigation (Salinised soil): Total irrigated area affected by salinisation as a result of irrigation. This does not include naturally saline areas.

Average precipitation (mm/year and km3 / year): This is the annual average precipitation based on the surface area and the time period, supplied by the meteorological stations in each country; given in height or volume, referring to given period.

Basin irrigation: Basins are flat areas of land surrounded by low bunds which prevent water from flowing to the adjacent fields. Basin irrigation is commonly used for rice grown on flat lands or in terraces on hillsides. The basin irrigation is suitable for crops that are unaffected by standing in water for long periods (e.g. 12-24 hours)

Border irrigation: Borders are long, sloping strips of land separated by ridges called bunds. They are sometimes called border strips.

Cost recovery: Fee structures that cover the cost of providing the service.

Cropping intensity: Harvested surface divided by cultivated surface, for one year. Formal definition is “the cropped area annually across season divided by the cultivated surface area”. If more than one crop is cultivated, then the intensity >1. It is an indication of the number of crops per year cultivated on a given area. For example, if there are two seasons, then the area is used twice, and the cropping intensity is 2.

Cultivated area: This represents the land devoted to both arable and permanent crops and should be distinguished from the usable agricultural land-UAL.

Decentralisation: The distribution of responsibilities for decision making and operations to lower levels of government, community organisations, the private sector and non-governmental organisations.

Deconcentration: The distribution of responsibilities to regional directorates within the same central agency structure.

Demand management: The use of price, quantitative restrictions and other devices to limit the demand for water.

Drip irrigation: With drip irrigation water is conveyed under pressure through a pipe system to the fields, where it drips slowly onto the soil through emitters or drippers which are located close to the plants. Only the immediate root zone of each plant is wetted. Therefore this can be a very efficient method of irrigation. Drip irrigation is sometimes called trickle irrigation.

Ecosystem: A complex system formed by the interaction of a community of organisms with its environment.

Endorheic: A closed basin without a connection to any ocean. For instance, the Jordan-Dead Sea endorheic basin.

Equipped area (full or partial control irrigation): Irrigation schemes executed and managed either by government, private estates or farmers, and where a full or partial control of water is achieved. Gardening is included in this category. (FAO)

Externality: The unintended real (non monetary) side effect of one party's actions on another party that is ignored in decisions made by the party causing the effects.

Financial autonomy: The ability of an entity to operate and sustain its activities for a long period based on the revenue it collects from the users of its services.

Food security: the capacity for a state to ensure enough food is provided to its population to satisfy the needs of that population. This food is not necessarily produced within the territory of the state. It may be imported. Food security is attained provided there is a secure provision of this food no matter whether it is imported or not. International agreements concerning stable cereal prices therefore enter into the construction of food security (Trottier, 1999).

Food self-sufficiency: the capacity for a state to produce enough food within its territory to satisfy the needs of its population. This entails a technical, economic and political capacity as well as sufficiently favorable climatic conditions and environmental endowment. Food self-sufficiency is beyond the reach of Jordan, Israel, Egypt and the Palestinian Territories. However, food security can be ensured (Trottier, 1999).

Furrow irrigation: Furrows are small channels, which carry water down the land slope between the crop rows. Water infiltrates into the soil as it moves along the slope. The crop is usually grown on the ridges between the furrows. This method is suitable for all row crops and for crops that cannot stand in water for long periods (e.g. 12-24 hours)

Gravity irrigation: A system that depends on sloping canals and fields to transport water to an irrigated site (IBRD definition).

Irrigated cultures: Sum of irrigated and harvested areas of land necessary to each crop during the given year. Areas under many cropping should be counted many times.

Irrigated surfaces: Area of land equipped for irrigation development. Are included surfaces equipped for full or partial control irrigation, spate irrigation areas, equipped wetlands and inland valley bottoms. It does not include cultivated wetlands nor flood recession cropping areas.

Irrigation methods: Various methods can be used to supply irrigation water to the plants. There are three commonly used methods: 1-surface irrigation (basin irrigation, furrow irrigation, border irrigation); 2-sprinkler irrigation; 3-drip irrigation.

Irrigation potential: Area of land suitable for irrigation development, taking into account land and water resources. It includes land already under irrigation

Land under permanent crops refers to land cultivated with crops that occupy the land for long periods and need not be replanted after each harvest, such as cocoa, coffee and rubber, it includes land under shrubs, fruit trees, nut trees and vines but excludes land under trees grown for wood or timber.

Overexploitation Index: This shows the depletion of groundwater. This is the annual quantity of water withdrawn from aquifers that is not replenished. The balance between water supply and water demand is an indicator of national surplus or deficit.

Participatory management: A form of management where the stakeholders are directly involved in decision making.

Potential evapotranspiration: This is the rate of water loss by evaporation from an actively growing short green crop freely supplied with water. It can be calculated from weather data and thus represents a theoretical maximum rate of evapotranspiration. The actual evapotranspiration is less than this when crops incompletely cover the ground or are short of water. However, it can be exceeded by tall crops with a closed canopy.

Renewable water resources: can be expressed as 1) Average flow formed in the country (km3/yr), or 2) Average flow imported from neighbouring countries, or 3) Total average flow available (km3/yr), or 4) Average fresh water resources per capita (m3/yr/person) (Gleick 1993 and Margat 1989 for specific data on EEC countries)

River basin: A geographical area determined by the watershed limits of a water system including surface and groundwater flowing into a common terminus.

Salinity: The overall salinity of water corresponds to the total number of cations and anions. It is measured in electric conductivity (EC). Causes for salinity are diverse. A study in Pakistan showed three main causes for salinity: 1) genetic salinity due to the weathering of parent material, 2) the rise of groundwater tables which displaces salts and brings them into the root zone thought capillary rise, and 3) the use of poor water quality groundwater by public and private tube wells (Kuper, 1997).

Shadow price: In situations where there is no actual price a shadow price can be derived to represent the price that would have been levied.

Sodicity: Higher concentration of Na+ than Ca2+ in the soil complex

Spate irrigation: It is a type of surface irrigation. Area of land equipped for spate irrigation (irrigation by river in full spate. Surface irrigation methods could also be called gravity or spate methods. Flood and furrow are two different kinds of surface methods (Kruse, E.G., Bucks, D.A., Von Bernuth, R.D., 1990).

Sprinkler irrigation: Sprinkler irrigation is similar to natural rainfall. Water is pumped through a pipe system and then sprayed onto the crops through rotating sprinkler heads.

Surface irrigation: Part of the full or partial control area under surface irrigation This is the application of water by gravity flow to the surface of the field. Either the entire field is flooded (basin irrigation) or the water is fed into small channels (furrows) or strips of land (borders) (FAO definition).

Total exploitable water resources: This indicates the resources that can be technically exploited taking into account preservation of ecosystems. Total exploitable water resources are determined by the countries themselves.

Total water resources (natural conventional renewable resources). This includes groundwater and surface water (precipitation – evapotranspiration + inflow). Excludes desalination, reuse and fossil water.

Unaccounted-for water: The difference between the volume of water delivered to a supply system and the volume of water accounted for by legitimate consumption, whether metered or not (or the measured volume of supplied water that is produced or treated less the water that is consumed legitimately, the difference being what is stolen or lost).

Usable agricultural land (UAL): Equivalent to the total of arable land, land under permanent crops, fallow and unmanaged grazing land. In the Mediterranean countries the latter is generally small so where little land is fallow it is approximated by the cultivated area.

Water Balance (water budget): The water balance is in hydrological terms water resources estimated using a relatively long time period (19 out of 20 consecutive years in general). The information is available in hydrological monographs. This budget is broken down into: precipitation, evapotranspiration, and runoff. Expressed in mm/yr. For limitations of the indicator see Gleick, 1993.

Water course: A system of surface and groundwater that constitute, by virtue of their physical relationship, a unitary whole and flow into a common terminus.

Water demand or water use: This is determined by the requirements of the activities and the water supply conditions. Demands are covered by water productions: withdrawals, fossil waters extraction (non-renewable productions) to which are added non-conventional water sources (reuse, desalination)

Water Exploitation Index: Indicative of total water withdrawals of conventional resources divided by total water resources (%).

Water need: A theoretical concept defined by the necessities and purposes of the activity generating it, and the efficiency of water uses -for a given quantity and quality- in relation with the results. Therefore, this need is, most of the time, expressed per unit (per capita, irrigated hectares, production unit). The water need has a normative (a reference used for current demand calculation) and forecasting nature. It is independent from the supply.

Water scarcity: Estimated through per capita water availability and per capita water demand. Overusing water resources means water demand exceeding water renewability (e.g., Lybia and the overuse of fossil groundwater)

Water supply resources: Conventional water resources are the natural resources (surface and groundwater). Non-conventional water resources come mostly from the desalination of sea and brackish water and wastewater reuse.

Water supply: Water availability

Watershed management: A process of formulating and implementing a course of action that involves a region's natural and human resources taking into account social, political, economic, environmental and institutional factors operating within the watershed, the surrounding river basin and other relevant regions to achieve desired social objectives.

Wetland: are areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres. They may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six metres at low tide lying within the wetlands. (Article 1.1. and 2.1. of Ramsar Convention on Wetlands of International Importance, 1971)

Withdrawals: Average water flows either diverted from their natural environment towards distribution networks or directly used.

Annexe. List of Participants to the POLAGWAT Workshop Water, Land, Agriculture and Policies in the Mediterranean (Brussels, 19-20/04/01)

Name	Institution
ANTONIUS, R.	Centre d'études ethniques, Université de Montréal C.P. 6128 Succursale Centre-Ville Montréal, Qc, H3C 3J7 CANADA Tel +1. 514 343-6111 ext 4029 Fax : +1. 514 343-7078 antoniur@magellan.umontreal.ca
ARAUS, JL	EC, DG Research Jose-Luis.Araus-Ortega@cec.eu.int Tel +32 229 60973
BLOCH, H.	EC DG Environment, B1 unit Helmut.Bloech@cec.eu.int Tel +32 229 90672
BORRI, D.	Politecnica de Bari Tel +39 080 5969 347 Fax +39 080 5460 348 incosusw@iamb.it
BORSALINO, G.	EC, DG Research Giuseppe.Borsalino@cec.eu.int Tel +32 229 94061
BROMLEY, D.	Univ of Wisconsin 331 Taylor Hall, WI 53106 Madison USA Tel +1 608 262 6184 Fax +1 608 265 30 61 bromley@aae.wisc.edu
CARAZO JIMENEZ, L.	DG Environment, B1. Luis.Carazo-Jimenez@cec.eu.int Tel +32 229 60066
CASA, R.	University degli Studi della Tuscia, Dip. di Produzione Vegetale via S.Camillo de Lellis Viterbo I- 01100 ITALY Tel +39 0761 357 559 Fax +39 0761 357 558 rcasa@unitus.it
De HAAN, L.	Katholieke Universiteit Nijmegen CIDIN Center for International Development Issues Nijmegen PO Box 9104 6500 HE Nijmegen THE NETHERLANDS Tel. +31-24-361 3058 Fax. +31-24-361 5957 L.deHaan@maw.kun.nl
De HAAS, H.	Katholieke Universiteit Nijmegen CIDIN- Center for International Development Issues Nijmegen PO Box 9104 6500 HE Nijmegen THE NETHERLANDS Tel. +31-24-361 3058 Fax. +31-24-361 5957 h.dehaas@maw.kun.nl

Name	**Institution**
ESCADAFAL, R.	CESBIO 18, av.Edouard Belin 31401 Toulouse Cedex FRANCE tel: +33 (0)5 61 55 85 23 (std: ~01) fax: +33 (0)5 61 55 85 00 richard.escadafal@cesbio.cnes.fr
HARUVY, N.	Agronomic Research Organisation ISRAEL Tel +972 3 968 38 23 Fax navaharu@netvision.net.il
HERZENNI, A.	Institut IAV Hassan II Département des sciences humaines BP 6202 Rabat MOROCCO Tel. +212 37 79 59 31 Fax + 212 3 777 51 95; aherzenni@fusion.net.ma
HUIBERS, F.P.	Wageningen University Irrigation and Water Engineering group Nieuwe Kanaal 11 6709 PA Wageningen NETHERLANDS Tel +31 317 484267/4190 Fax +31 317 484759 Frans.Huibers@users.tct.wan.nl
KASER, F	EC, DG Research Ferdinand.Kaser@cec.eu.int Tel +32 229 93135
KROLL, A.	IPTS, Institute for Prospective Technological Studies Joint Research Center, EC WTC Isla de la Cartuja 41092 Sevilla SPAIN Tel +34.95.448.8458 Fax +34.95.448.8235 adeline.kroll@jrc.es
KUT G.	Bogazici University Bebek 80815 Istanbul TURKEY Tel +90 212 263 15 40 Fx +90 212 257 50 16 kut@boun.edu.tr
LIPCHIN, C.	Arava Institute for Environmental Studies Kibbutz Ketura, D.N. Hevel Eilot 88840 ISRAEL Tel +972-8-635 6675 Fax +972-8-6356465 clive@arava.org

Name	**Institution**
LO CASCIO, B.	University degli Studi della Tuscia Dip. di Produzione Vegetale via S.Camillo de Lellis Viterbo I- 01100 ITALY Tel +39 0761 357 555 Fax +39 0761 357 558 locascio@unitus.it
MATHIEU, P.	Catholic Univ of Louvain IED Institut d'Etudes du Developpement Louvain la Neuve Place des Doyens, 1, 1348 BELGIUM Tel +32.10 47 39 42 Fax +32.10 47 28 05 mathieu@dvlp.ucl.ac.be
NEGRE, T.	ISPRA, Joint Research Centre, EC ITALY Tel+39 0332 786102 Fax thierry.negre@jrc.it
NETO, S.	Technical Univ of Lisboa Rua Prof. Delfim Santos, Nº 9 1º D 1600-610 Lisboa PORTUGAL Tel/Fax +351 21 7599758 jmhenrsneto@mail.telepac.pt
ORTHOFER, R.	Austrian Research Centre Seibersdorf AUSTRIA Tel +43 50550 3813 rudolf.orthofer@arcs.ac.at
OZKAN, A.	Istanbul Bilgi University Inonu Cad, 28, Kustepe 80310 Sisli, Istanbul TURKEY Tel +90 212 216 23 01 Fax +90 212 216 24 00
RUF, T.	Dynamiques sociales de l'irrigation IRD (Institut de recherche pour le développement) BP 5045, 34032 Montpellier Cedex 1 FRANCE Tel :+33 4 67 63 69 76 Fax +33 4 67 63 87 78 thierry.ruf@mpl.ird.fr
RUSSELL, G.	University of Edinburgh Institute of Ecology & Resource Management (Agriculture Building), West Mains Road Edinburgh EH9 3JG SCOTLAND Tel +44 131 535 4063 Fax +44 131 667 2601 g.russell@ed.ac.uk

Name	**Institution**
SANTAMARIA, L.	NIE, Netherlands Institute for Ecology The Netherlands Tel +31 294 239 358 Fax +31-294-232224 santamaria@cl.nioo.knaw.nl
SCARPA, D.	Bethlehem University PALESTINE Tel +972 22 74 12 46 Fax +9722 274 4440 dscarpa@bethlehem.edu
SEOANE, I.	DG Research Tel +32 229 62022 Ignacio.Seoane@cec.eu.int
SHALHEVET, S.	Agronomic Research Organisation ISRAEL Tel +972 3 968 38 23 Fax sarit@agri.gov.il
TERRES, JM.	ISPRA, Joint Research Centre, EC ITALY Tel +39 0332 785254 Fax jean-michel.terres@jrc.it
TREYER, S.	ENGREF 19, avenue du Maine - 75732 PARIS CEDEX 15 FRANCE Tel +33 1 45 49 89 12 Fax +33 1 45 43 88 27 treyer@engref.fr
TROTTIER, J.	Oxford University Oxford Centre for Water Research Mansfield Rd 1a Oxford OX1 3TB UK Tel +44 1865 281218 Fax julie.trottier@eci.ox.ac.uk
VIDAL-MADJAR, D.	IPSL/UVSQ/CNRS-CETP 10-12 Avenue de l'Europe, 78140 Vélizy, France Tel :+33 139254816 Fax :+33 139254822 Cel :+33 683122225 daniel.vidal-madjar@cetp.ipsl.fr
VINALS, JM	Politécnica de Valencia EPS de Gandía C Nazaret –Oliva 46730 Gandía Valencia SPAIN Tel +34 962 84 93 09 Fax +34 963 84 98 16 mjvinals@uv.es