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Lacirignola C., El Kady M., Hamdy A.

in

Hamdy A. (ed.), Trisorio-Liuzzi G. (ed.).
Water management for drought mitigation in the Mediterranean

Bari : CIHEAM
Options Méditerranéennes : Série B. Etudes et Recherches; n. 47

2004
pages 283-322

Water Saving Options and Agricultural Drought Mitigation in the Mediterranean: The EU-CIHEAM/IAM Bari, Regional Action Programme (RAP)

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Introduction

The dry areas of the Mediterranean face sever and growing challenges due to the rapidly growing demand for water resources. New resources of water are increasingly expensive to exploit, limiting the potential for expansion of new water supplies.

Water scarcity is specific relative to region, location and season. The criterion for water scarcity is that countries with freshwater resources in the range 1 000 – 1 600 m^3 per capita per year face water stress, with major problems occurring in drought years. When annual internal renewable water resources are less than 1 000 m^3 per person annually, countries are considered water scarce. Below this threshold, water availability becomes a server constraint on socio-economic development and environmental quality. Nowadays and in the few coming years, non of the southern and eastern developing countries of the Mediterranean will have resources exceeding and average 500 m3/per capita/per annum, which clearly highlights that the problem will become increasingly acute.

In the region, the complexity in the water resources situation is not only due to the water scarcity but also to the sever and long lasting drought conditions, with increasing frequencies occurring in most of arid countries in the region. Furthermore, major water resources in the region are shared between countries lying both within and beyond the region. The most significant river basins are those of Jordan, the Nile and Euphrates/Tigris, all of which are subject to contentious riparian issues. In addition, deteriorating water quality is an increasing serious issue in many areas. Declining quality directly affects the utility of the

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resource, and treatment costs will rise steeply if rivers and potable aquifers are to be sustained in usable forms.

Agriculture sector is by far the largest user of water in the region. On a consumptive use basis, 80 to 90 percent of all the water is consumed in agriculture. Unfortunately, the water use efficiency in this sector is very poor not exceeding the 45% with more than 50% water losses, and thereby, enormous water saving could be achieved in the agricultural sector comparable with the other sectoral water use.

Climate change and its uncertainly that has so far filled our thoughts are nowadays well felt and clearing appearing in the Mediterranean with the sequences of higher temperature, extreme rainfall or droughts. Such prospects on one hand, and the water scarcity on the other hand, both point to the big challenges that require for greater efforts, significant changes and urgent adaptation in How water is managed in the agricultural sector? What needs to be changed in irrigation policies? What are the improvements required to cope with increased water scarcity and drought conditions?

Aware of this, during the last decade, the Mediterranean Agronomic Institute of Bari has been developed several programmes and research projects focused on the water saving in irrigated agriculture being the most appropriate approach the region has to follow to face the water scarcity problems and to combat the drought conditions. Any water saving in this sector, will not only lead to an appreciable increase in the limited water supply, but, in the mean time, will provide the other sectoral water uses with its water requirements and thereby, avoiding the arising conflicting problems among the different water sectors.

The experiences gained by Bari Institute in this field through the research programmes findings, and the accumulated know-how during more than 15 years of networking activities were the fundamental bases for a Regional Action Programme on "Water Resources Management (RAP – WRM), carried out by CIHEAM – Bari Institute with the frame of the EU DGI activities. The programme started in 1998 and lasted for almost 5 years, has involved beside Bari Institute, the most important scientific institutions and experts in irrigation and other sectors related to water resources development and management in the Mediterranean region. The National Water Research Center (NWRC), Cairo – Egypt, was the partner institution in the development and the folow-up of the programme in both its two phases of implementation. This work aims to synthesize main considerations and objectives of the RAP – WRM programme as well as to present the outputs and results achieved during this realization.

Water Crisis: The Emerging Question

Today, in most of the Arid and Semiarid countries of the Mediterranean, and in particular the developing ones, the emerging question is whether a water crisis can be averted or whether water can be made more productive. The answer to this question relies on the way we are using and managing water resources in the irrigation sector. The more we produce with less water and/or with the same amount of water, the less the need for infrastructure development, the less the conflicts among sectoral water uses, the greater the local food security and the more water available for agricultural, households and industrial uses, beside ensuring that it remains enough water for the nature.

Water Crisis: The Emerging Questions

- Whether water crisis can be averted or whether water can be made productive?
- How to meet the ample water demand at a time when pressures on resources are increasing and their mobilization is becoming increasingly expensive?

Indeed, those are the key issues of the philosophical approach focusing on agricultural sector in the RAP – WRM programme. The new in this programme is that its final goal is to increase the water supply to compensate for the notable shortfalls in the available water resources to meet the increasing water demand, not through the oriented supply management approach, but by adopting the oriented demand management one.

Main Considerations of the RAP – WRM Programme

The setup of the programme, the planning and the approaches to be followed during its run was carried out taking into considerations the followings:

Deep analysis of the water problems and their causes in the Mediterranean

The dominant fact that will be strongly evident over the next few decades in the structural imbalance between the constantly increasing demand for water to meet the needs (Fig. 1) and the natural available water resources.

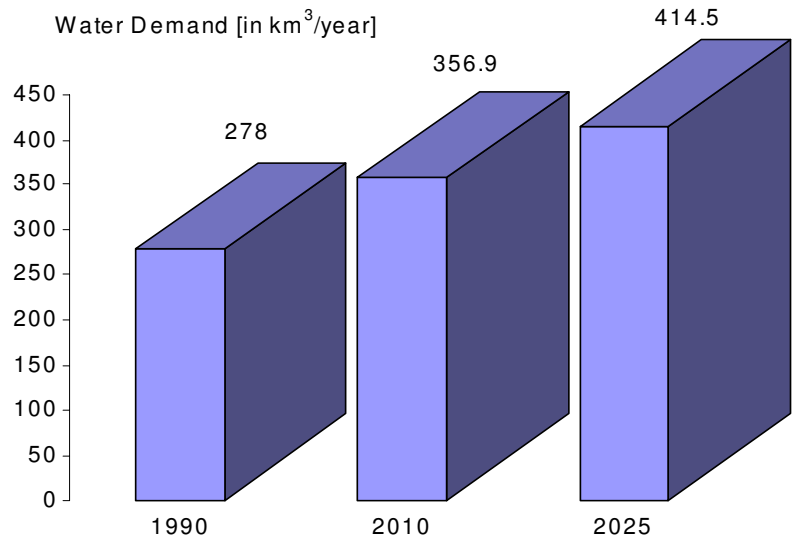

Fig. 1. Actual water demand (in 1990) and foreseen water demand for 2010 and 2025, in km^3/year.

As a matter of fact, in the majority of countries in the region such imbalance has already appeared around the year 2000 and beyond. Those countries are facing similar problems that can be outlined as follows (Hamdy, 2000 a):

- declining water withdrawals and water availability per person. It is expected that the available water per capita will be reduced to nearly 50% of the present one;

- over-exploitation of water at a relatively high rate, with the risk of water quality deterioration;

- excessive reduction in water withdrawals per capita, which will impose its significant effect on the water sectoral use, creating notable competition and conflicts among users in various sectors, in the irrigation and domestic sectors particularly;

- progressive degradation in the quality of atmosphere and available water resources because of increasing waste load discharged into water bodies.

Irrigation and agriculture water use

At present, the irrigated areas account for more than 16 million hectares; in 15 years, these areas have increased by 3 million hectares and the growth rate seems to stabilize around 200,000 hectares per year. This implies the use of a supplementary capacity in the order of 2 billion m^3 of water per year only for agriculture. This will certainly cause some difficulties for the partitioning of water resources between agriculture and the other sectorial water users. Abandoning irrigation in arid areas, however, destroys agricultural viability and has adverse multiplier and third party effects.

Irrigated Agriculture and Irrigation Water Management Characterizing Features:

- fragmented management approach is mostly dominant,
- incentives for water conservation are few and disincentives are numerous,
- irrigation is developing faster than the water source mobilization,
- centralized the irrigation water management by governments with the following sequences:
  - poor management practices, inefficient water use and failure to place high economic value on water;
  - resource degradation by water logging, soil and water salinization and pollution of aquifers;
  - increasing demand for water leading to rapid mining of aquifers, water shortages competition and conflicts.

Irrigation is extremely water intensive. It takes about 1000 tons of water to grow one ton of grain and 2000 tons to grow one ton of rice. In the Mediterranean area, irrigation represents 72% of the total water withdrawals. During the next twenty-five years, sustainable quantities of fresh water supplies will be diverted from agriculture to industry and households in the region. Irrigated agriculture will face two challenges of water shortages and dwindling financial resources. Despite theses challenges, irrigated agriculture will have to provide 70 to 75 percent of the additional food grain requirements to the developing countries of the region. This will not be possible without developing effective methodologies and systems for assessing and improving the performance of irrigated agriculture. Such systems have to evaluate the contribution and impacts of an irrigation scheme in terms of production, self-reliance, employment, poverty alleviation, financial viability, farmer's profitability and environmental sustainability (Hamdy, 2000 b).

Water resources development and management

The traditional approach – increasing water supply

Traditionally, solutions were fully focusing on the supply-side, relying on an ever-larger number of dams, reservoirs, and aqueducts to capture and store ever-larger fractions of freshwater run-off. Such

In the developing countries, given the increased cost of new irrigation development with the scarcity of land and water resources, the emphasis in the future will be more on making efficient use of water for irrigation and less on an indiscriminate expansion of the irrigated area.

approach is now criticized for environmental, economic and social reasons. Basic human needs for water still remain unmet and it is becoming harder and harder to find new water resources, or even to maintain the existing ones to supply croplands.

Under such traditional approach, water-planning efforts usually did not include a detailed analysis of how water is actually used. Equally, there was no clear identification of the common goals for water development to seek agreement on principles to resolve conflicts over water. In addition, little attention has been paid to protecting natural ecosystems from which water supplies have been withdrawn. Those are growing calls, beside others including high costs of construction, tight budgets, deep environmental concerns, pushing towards changing the way we are following in planning and managing our water resources.

Governments have typically emphasized supply management, but, as new water sources become increasingly inaccessible, the costs of projects to augment supply escalate. Many countries are already dependent on groundwater and despite the potential of further exploitation (from coasty deep aquifers), most countries face sever problems of depletion. Non-conventional sources include wastewater treatment and reuse, desalination; they are invariably more expensive than traditional sources, although in case of wastewater treatments, costs can offset against environmental concerns. Alternatives to such investments are conservation and improved management of existing supplies.

Water losses in the agriculture sector

In typical irrigation schemes as little as 40% of applied water may be used for covering evapotranspiration, while modern schemes, and there are examples of this within the region, can achieve project efficiencies about 65%. Assuming a typical situation where 80% of the total water is used for agriculture, a 10% increase in the efficiency of irrigation would provide 40% more water for municipal and industrial use. This is a good illustration of the potential of water saving in agriculture and the need to press for it due to the fact that there is considerable potential for efficiency improvements in this field using the variable tools and the technologies already existing in the region.

RAP – WRM: Objectives and Activities

The Regional Action Programme on Water Resources Management (RAP – WRM) is based on the above mentioned considerations and aims at implementation of policies and supported needed measures for

practicing and integrate demand water management approach in the agriculture sector to improve the efficiency of water use in this sector and a better water saving.

The (RAP – WRM) represents a part of large programme developed by CIHEAM and its four operational institutes within the frame of EU DGI activities. The overall objectives of the whole programme are human resources development, institutional capacity building and the improvement of regional cooperation in the agricultural sector through training, promotion of research and communication of scientific and technical information, with particular emphasis on sustainable agriculture and the transition to a more open and competitive market economy. The action programs are derived into 4 RAPs (each assigned to one of four CIHEAM Institutes) for training and for creation of research and information exchange networks based on the concept of "open centers" (centers without walls) in the following areas: water - irrigated agriculture (IAM-Bari), rainfed agriculture (IAM-Saragossa), food and agricultural policy including legislation aspects (IAM-Montpelier) and renewable natural resource preservation and utilization (IAM-Chania). The expected results of the whole program are: a better understanding of regional planning and its implementation, a more efficient regional cooperation and better information exchanges in the Mediterranean basin (South-South and North-South), an improved understanding and coordination of regional economies and compatible marketing policies necessary to facilitate economic transitions in the region.

The Regional Action Program on "Water Resources Management" (RAP-WRM), developed by MAI-Bari, aims to improve the institutional capacity building, human resources development and regional cooperation and exchange of experiences in the field of water resources and irrigation. The RAP-WRM is based on the concept of water demand management and it is oriented to the sustainable use of water resources in agricultural sector emphasizing technical, social and economic aspects through the following major issues (Fig. 2).

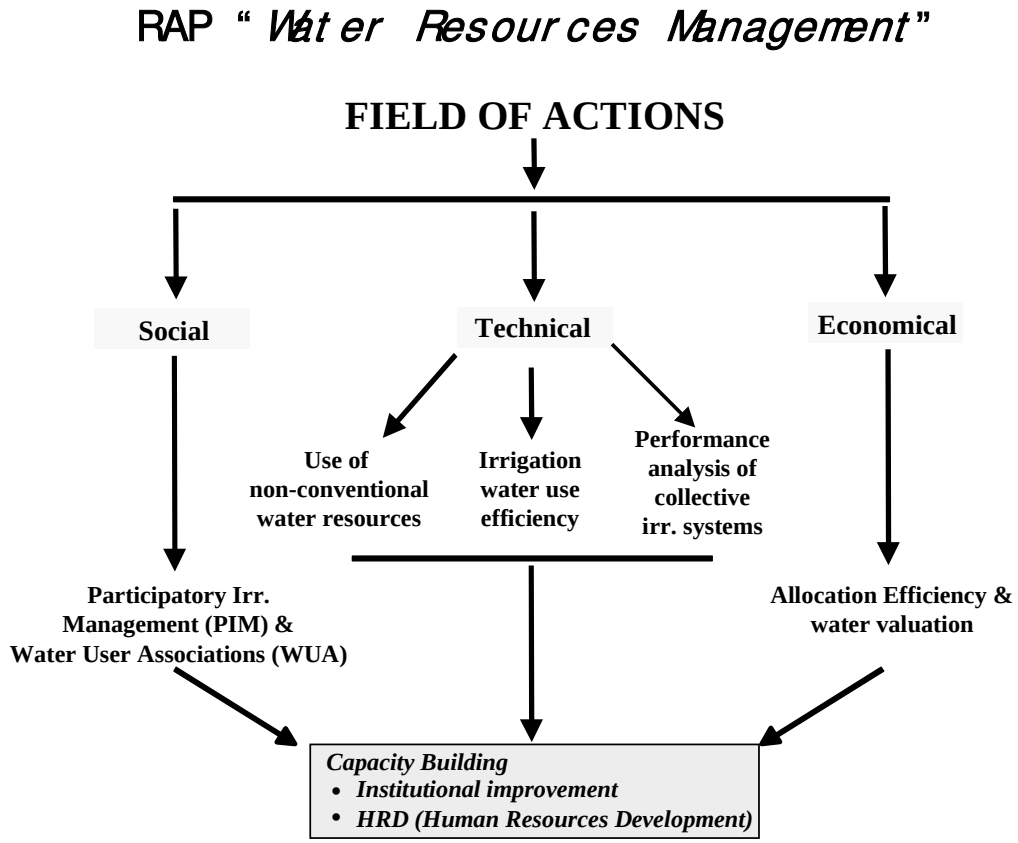

Fig. 2. Field of actions of RAP-WRM

Technical aspects

In the region, nowadays, it is well recognized that the reliance on physical solutions, although still continuing to dominate the traditional planning approach, failed in satisfying basic water requirements for human activities and, above all, it gave origin to several social, economic and environmental problems. Accordingly, for the RAP – WRM programme, water resources management was directed towards the soft path approach through developing new methods to meet the water demands of the growing activities in the water use sector and in particular the agricultural one without requiring major new constructions or new large scale water transfer from one region to another. Focusing is mostly given to irrigation efficiency improvements, implement options for managing demand, improving the performance of irrigation systems and introducing new irrigation technologies and the recycling and

RAP – WRM: **Technical Issues**

- water productivity (water use efficiency) improvement,
- improvement of irrigation systems,
- utilization of efficient technologies,
- conjunctive use of water supplies,
- non-conventional water resources use, reuse and recycling.

reuse of non-conventional water resource as an additional water supply source in irrigation practices.

Water-use efficiency and water productivity

One of the most extensively used terms to evaluate the performance of an irrigation system is water use efficiency (WUE). Unfortunately, in most countries of the region, the overall irrigation-efficiencies (the product of irrigation system efficiency and field application efficiency) is typically in the region 20 – 40 percent of water in the system is actually used beneficially.

These low water-use efficiencies are often cited as evidence that very large saving in water use can be obtained. However, they are derived from individual system evaluations rather than from basin-wide assessments.

Water Productivity Increase: Key Strategic Options

- to increase the productivity per unit of crop consumption (transpiration),
- to reduce non-beneficial evaporation or flows to sinks,
- to reduce pollution,
- to reduce unnecessary out flows, either through improved management of existing facilities or through development of additional facilities,
- to reallocate water to crops with high water productivity.

The efficiency concept is not directly related to the amount of food that can be produced with an amount of available water. In this respect, water productivity, defined as the amount of food produced per unit volume of water used is more useful.

Water efficiency and productivity terms should be used complementarily to assess the water management strategies and practices used to produce more crops with less water. Both terms are scale-sensitive; therefore, failure to clearly define the boundaries of the special domain of interest can lead to erroneous conclusions. It is also important to specify the water-use components that are taken into account when deriving WUE and productivity.

On-farm, the water-use efficiency in producing food can be improved by changing cropping pattern towards less water-demanding crops by reducing wasteful applications of water and by cutting field to plate losses. Also, increasing yield per unit evapotranspiration during crop growth; reducing evaporation especially during land preparation, reducing seepage and percolation during land preparation and crop growth periods and reducing surface runoff, are effective measures for increasing on-farm productivity for irrigation water.

However, achieving greater productivity to resolve water crisis will not happen automatically, it will require great effort and it is especially

feasible in the developing countries of the region, where water productivity is far below potential. For example, if a country's demand for grains grows by 50%, one way to match this rise is to increase the productivity by 50%. Increasing the water productivity up to this level will be very difficult to achieve, unless we have fully in hand, not only the appropriate actions, but equally the needed tools for its implementation on the ground. Indeed, those are the main issues the RAP – WRM programme is focusing on.

Deficit irrigation

The potential benefits of deficit irrigation derive from three factors: (1) increased irrigation efficiency, (2) reduced costs of irrigation and (3) the opportunity cost of water. Accordingly, a part of the research project (WASIA) was dealing with deficit irrigation practices to find out the optimum level of applied water for a particular situation which produces the maximum profit of crop yield, per unit of land, per unit of water, in view of the underlying objective functions and the limiting constraints.

Design, performance evaluation and management of collective irrigation systems

Under this technical aspect, focusing was given to:

- *Improvement of irrigation systems*

In the developing countries of the Mediterranean, the major physical and technical problems and constraints in irrigation systems are: inefficient water use, shortage of water supply at the source, poor canal regulation, waterlogging and salinity, poor operation and maintenance, small-scale programmes and scarce water resources. Such problems and constraints require a set of common supporting actions, namely the development of adequate data bases, adaptative research, institutional strengthening, human resource development, improvements in socio-economic analysis, environmental protection, technology transfer and infra-structure development. Such supporting action were fully considered during the run of the programme.

- *Water conservation through appropriate technology*

If improved demand management introduces incentives for water conservation, the availability of appropriate technology will be essential to generating water savings. As the value of water increases, the use of more advanced technologies (such as drip irrigation utilizing low-cost plastic pipes, sprinklers and computerized control systems,

used widely in developed countries) could have promising results for developing countries. Any evaluation of the impacts of these technologies must take into account the difference between consumptive use of water and water withdrawals or applications. All of these advanced technologies can significantly reduce the amount of water applied to a field, reduces the amounts of drainage and increases the actual water savings. In countries where the sccarcity value of water is high enough, appropriate use of new technologies appears to offer both real water savings and real economic gains to farmers.

New technologies should also be introduced, implemented and adapted to the existing irrigation systems for its modernizations. This can be done through the use of hydraulically operated diversion and the development of measuring devices. Such technological opportunities will provide the delivery of water on demand to individual farmers, allowing water users to be charged according to the value of water actually delivered, thus encouraging conservation and efficient use of water. This is indeed a realistic water saving in the irrigation sector.

The major constraints to the expansion of such technologies mainly involves the high cost of operation, particularly the cost of energy. Another major constraint is the lack of appropriate maintenance services for modern irrigation equipment, as well as the poor coordination between research institutions and industries.

Modern irrigation techniques need to be carefully selected and adapted to the local physical agronomic and socio-economic development, as well as to the technical and managerial skills of local farmers. Upgrading existing irrigation schemes should, in most cases, be preceded by pilot schemes to test alternative design concepts. Costly improved technologies can only be justified if their agronomic and economic potential is fully exploited.

Collective irrigation systems and how to improve occupied the center activities of RAP – WRM programme due to its influential impact on water use efficiency and the sustainable use of non-conventional water resources, both, representing major opportunities for water saving.

Alternative Water Supplies (Non-Conventional Water Resources)

The ever more acute scarcity of freshwater availability has encouraged the adoption of investigation on new forms of water supply. Seawater desalination has been the object of intense research, which has

succeeded in considerably reducing the treatment costs, resulting in an appreciable diffusion of such techniques and in an enrichment of know-how; however seawater desalination is still too expensive in economic and energetic terms to be proposed as a large-scale solution for agriculture. Actually, its cost in excess of USD 0.50/m^3 confines its use to high value crops. Towing icebergs or using large tankers to produce freshwater are solutions that have been proposed and experienced on a limited scale, but have enjoyed no wide acceptance.

Basically, only two non-conventional water resources can be proposed at present, namely the saline brackish waters and urban wastewaters, both of them entailing some degree of risk and in need of further research.

Saline irrigation

The experience gained by Bari Institute in this field through more than 15 years of net-working activities on "non-conventional water resources practices and management", the research findings of several programmes realized in cooperation with regional and national organizations in the Mediterranean, as well as the individual research carried out by Bari Institute, came up with the following features characterizing the use of saline water in irrigation:

- In the Arid and Semiarid countries of the Mediterranean, there is a high potentiality of using saline water as an additional source.

- Recent research development on salt tolerance of various crops, water, soil and crop management, irrigation and drainage effluents, will enhance and facilitate the use of relatively saline water for irrigation

Major problems constraining the wide use of saline water are:

- The existing guidelines, which were worked out in a period of unlimited freshwater resources are very conservative and therefore in need of being profoundly revised; they do not take into account the complex relationships in the soil-plant-atmosphere continuum nor give sufficient emphasis to the type of management, which has a considerable impact on plant response.

- Ranking plant response to salinity according to a generic "yield reduction" has been criticized as a non-scientific approach and the adoption of more soundly based approaches are to be suggested.

- The use of saline water for irrigation is a complex practice.

- Most work on potentials and hazards of the use of saline water, mostly done under controlled conditions, and less under real conditions (the open fields). In some cases, the available data are hardly and not successfully used in practice.

- At present, in most countries of the region, there are no defined policies and strategies on the saline water use and on the mitigation of its environmental impacts. The lack of effective monitoring systems and programmes on both quantities and qualities is one of the main reasons.

- Most of the activities in this field carried out by different institutions and organizations were undertaken in relative isolation and no mechanism existed for coordinating the research work to avoid duplication and to ensure that the findings are effectively used.

- The region is very rich in the cultivars of dominant crops, but the databank for their classification with respect to their tolerance degree is absent on the national and regional levels.

In this regard, the activities in the RAP – WRM project were oriented to setup new strategies for sustainable saline water use in irrigation in a way that is technically sound, economically viable and environmentally non-degrading. The programme within its two phases gave more emphasis on the followings:

- to enforce working relationships on regional, national and international institutions dealing with the subject through the existing network on non-conventional water resources practices and management.

- To conduct and foster a comprehensive multi-disciplinary basic and applied research programme in coordinating fashion on the sustainable use of saline water in irrigation and related problems and obstacles (WASIA – Project).

- To develop practical solutions to problems associated with saline management aspects.

- To develop on both national and regional level the guidelines for safely use of drainage and saline brackish water.

- To provide facilities for research workers and to train associated personnel in techniques and methods dealing with saline water practices and related salinity problems.

- To promote the dissemination of information to farmers and their participation and involvement in planning and management processes to diminish the existing gap between researchers, the technical assistance personals and the users.

Municipal treated wastewater

Expansion of urban population and increased coverage of domestic water supplies and sewage network will give rise to greater quantities on municipal wastewater which can become a new water source, particularly for irrigation. The water recycling and reuse provide a unique and a viable opportunity to increase traditional water supply. Water reuse can help to close the loop between water supply and wastewater disposal. The successful development of this reliable water resource depends upon close examination and synthesis of elements from infrastructure and facilities planning, wastewater treatment plant siting, treatment process reliability, economic and financial analysis, water utility management, and public acceptance.

To overcome water scarcity and combat drought in the arid countries of the region, as priority options to be followed:

- efficient programme leading to increasing water productivity and water saving in all sectors and in particular the agricultural one.
- To collect, to treat, to reuse and to recycle each drop of wastewater.

Urban wastewaters are a very promising non-conventional resource, deserving full consideration for at least three good reasons:

- their use permits to free freshwater resources to satisfy more pressing uses (domestic, industrial);

- they are presently a costly burden for their treatment;

- they are rich in organic matter and fertilizers (which can be a blessing to the crops but pollute the environment if released without control).

On the other side, the uncontrolled use of urban wastewaters implies risks to the health of irrigators and consumers and is potentially harmful to the soils, the aquifers and the water bodies due to the heavy metals, the parasites and the pathogens they could carry. As a consequence, an a priori evaluation of the level of treatment needed for a safe use, and the total maximum daily load (TMDL), namely the permissible amount of pollutants for any particular environment, are

necessary. The ever-shrinking freshwater availability encourages the reuse of wastewaters for irrigation: for instance, Tunisia is planning to irrigate 30.000 hectares with them, while Egypt has a programme to treat nearly 3 billion m3 by the year 2010 (Hamdy, 2001).

In the region, it is now widely recognized that treated wastewater (TWW) reuse constitutes an important and integral component of the comprehensive water management programs of the majority of countries, more so in the water scarce ones. This implies that these countries should have national policies and strategies relating to wastewater management, in general, and wastewater reuse for agriculture, in particular, in order to guide programs, projects and investments relating to wastewater collection, treatment, reuse and disposal in a sustainable manner.

Problems with reuse

A major problem with the reuse of wastewater for irrigation is the determination of the treatment level in order to make them safe, i.e. the appropriate guidelines for use. Unfortunately, with some few exceptional countries, in many developing countries of the region, such standards and guidelines are still absent. This is seriously impacting the diffusion and the safe reuse of treated wastewaters.

In the Mediterranean, the annual water use in domestic and industrial sectors could reach 83 BCM. Assuming that 80% of the wastewater will be collected and treated, we can have an annual additional water supply of 66.7 BCM to be allocated to the agriculture sector. In the Mediterranean, the existing wastewater-reuse is only 0.75 BCM.

In the region, to achieve the full use of this important resource, it is now a must to set the appropriate national guidelines for the reuse that cope with the prevailing local conditions. This will require:

- First, to collect and elaborate the results of the on-going research (networking activities) to obtain those data which are required to establish economically feasible, safe and socially acceptable set of standards, regulations and codes of practices for sustainable use.

- Secondly, to select the proper wastewater technology to be adopted under the prevailing local conditions. The choice should rely on those entailing excessive costs and providing the best environmental practice and option.

- Thirdly, the treated wastewater of specific characteristics should be experimentally tested to identify the appropriate irrigation practices and management for sustainable use.

These fore-mentioned perquisites are the ones where the activities of RAP – WRM programme were directed to.

Reuse and recycling practices: conjunctive use of water supplies

The conjunctive water use is one of the approaches to be highly recommended in the Mediterranean countries and particularly those suffering from acute water shortages. It provides high potentiality for the re-use and recycling of each drop of wastewater from the different sectoral water use, providing additional water supply to the irrigation sector and reducing the fresh water use in this field. Yet, in most countries in the region the conjunctive water use is rarely or not practiced at all.

Conjunctive Water Use:
Achievable Objectives

- mitigating the effect of the shortage in canal water supplies,
- increasing the dependability of existing water supplies,
- alleviating the problems of high water table and salt intrusion,
- facilitating the use of poor quality water due to appropriate dilution,
- storing water in groundwater basins closer to the users in case of interruption of surface water supply,
- minimizing the drainage water disposal problem.

Indeed, to make the conjunctive use of water fully operational (Hamdy, 2003 b); the following conditions should be satisfied:

- policies and regulation must be in place and enforced to ensure that waters of varying quality are used in accordance with approved standards of use. Difficulties often lie in the enforcement of legislation within an administrative structure, translating the regulatory objectives into a decentralized strategy;

- scientifically based standards of water use and standards for discharge to water system must be prepared, confirmed and put into effect;

- regulation to enact water use standards must be flexible to allow a structured phase-in of the final standards. A strategy to reach compliance over a specified time period should be built into the phase-in program or else that compliance will never occur;

- a precise database is needed on the availability of each water supply, in quantity and quality, temporally (when it is available) and spatially (where it is located);

- economics comes into the planning process when water supplies are linked to potential water uses.

In RAP – WRM programme, the conjunctive use of water of different qualities was practiced within the WASIA research project to elucidate the impact of irrigation with waters of different qualities (alternation technique) on the soil productivity, crop production and possible water saving.

What we like to emphasize here is that the soft path of water and conjunctive use of all water supplies are core components of an integrated water resources management programme (RAP – WRM) that looks at water sources in the context of the entire economic, social and ecologic system of the nation.

Economic Aspects

Water valuation and cost-recovery mechanisms

In the developing countries of the Mediterranean, the cultural and socio-economic values of water are still a very elusive subject. Several learned meetings stressed the economic value of water, while others stressed its social and cultural values.

Economic incentives based upon cost recovery of irrigation water supply may play a major role in improving irrigation water demand by creating incentives for the farmers to save irrigation water. In the southern Mediterranean countries, irrigation water is provided either free or for less than the full cost of providing irrigation services. Most irrigation projects are being subsidized in order to support agricultural production. But, due to recent budgetary constraints, the increasing water scarcity and the increasing water demand, some countries are moving toward reducing such subsidies in order to generate enough revenues for operation and maintenance for the irrigation schemes; reducing the burden of the government budget; and at the same time, creating direct or indirect incentives for farmers to invest in irrigation saving technologies and to shift cropping patterns out of high water consuming crops.

Inappropriate water valuation policies and economic subsidies encourage wasteful use of water in irrigation sector. Water should be regarded as a **socio-economic good**.

In the Mediterranean region, the introduction of irrigation charges is a very important pre-requisite to good management of irrigation demand because it is noticed that despite the observed water shortages, misuse of water in agriculture is widespread in current irrigation management practices. This is due mainly to the failure in the past to recognize water's economic value and the real cost of water services provision. Therefore, it is now widely believed that managing water as a socio-economic good is an important tool of achieving efficient and equitable water use as well as encouraging the conservation and protection of scarce water resources.

Yet, for many Arab states in the region, it is difficult to reconcile the concept of water as an economic good with the traditional idea of water as basic necessity and a human right. In this regard, the action should be directed to the use of non-price measures to encourage consumers to use water more efficiently, including the followings:

- transferring managing responsibilities for operations and maintenance to user's groups;
- promoting water rights and water markets.

In the Mediterranean, developing a unified approach is required with clearly defined associated conditions and limitations for its applicability, which should accommodate the diversity of the countries in the region.

This is what the decision makers for most countries in the region are asking and looking for as an aid to set the national water valuation policies. This subject was fully confronted in a special workshop in Agadir, Morocco, considering the favorite and opposite options as well as the positive and negative impacts to decide on specific recommendations be helpful in the valuation of irrigation water.

Social Aspects

Participatory irrigation management (PIM) and water users associations (WUAs)

In the Mediterranean countries, particularly the arid and semiarid ones, around 80% of the available water resources are allocated to irrigation. In these countries, the state is the central actor in developing and managing irrigation systems.

Despite the high priority and massive financial resources invested in the water resources development, the government-operated irrigation

systems are often poorly maintained with steadily deteriorating infrastructure. In addition, the mismanagement irrigation project schemes lead to the sterilization of some of the best and most productive soils. Salinity and water logging, as well as degradation of water quality and pollution of aquifers, now seriously affect productivity in the majority of the Mediterranean countries.

The failure of the centralized government systems in administrating irrigation water resources calls to a rapid change in irrigation management through implementing participatory irrigation management and transferring the irrigation system management to water users associations (WUAs)

Faced with the clear need for training related PIM, during the running of RAP- WRM programme, three training programme were developed.

Gender and water resources management

Gender issues are context dependent. Each culture has its own way of characterizing female and male role in society. Clearly issues affecting women have become predominant features of public debate for gender balance and mainstreaming.

To pursue a harmonious and systematic development of national and regional agenda and policies in the Mediterranean region, gender perspective in water sector must ensure the interests and needs of women as well as men. Gender issues at times have been confined as "women development" and kept compartmentalized as a marginal programme within water sector.

In the Mediterranean countries, particularly in the developing ones, we are still in need of a hard work, and great efforts to bridge the gap between women and men in order to bring women into the mainstreaming of thinking. There is a need for devising strategies to attract attention of society to the contribution of women in economic emancipation within water sector that affects the overall water policy of the country. Furthermore, although in the region, gender is a priority on the agendas of irrigation policy-makers, irrigation leaders and researchers, however, a deep gender analysis highlights the considerable gap between positive policy intentions and their conversion into concrete action.

Such situation as well as the presence of several imposing negative factors impacting slowing the gender implementation policy ask for new gender strategies to be implemented in the region providing the solutions to the existing constraints and leading to promotion of gender

in policy planning to encourage and empower women through management of water and structure for irrigation. What could be this strategy? What is the most appropriate approach? What are the enabling conditions needed for putting the strategy in action? These questions and others were the reasons behind the workshop held in Cairo, Egypt, October 2002.

RAP-WRM: Outputs and Results

Institutional capacity building and human resources development

Training - Advanced Short Courses

In the period 1999-2002, twelve advanced short-term courses were carried out, three in each year, in eight different Southern Mediterranean countries (Algeria 1; Egypt 2; Jordan 1; Lebanon 1; Malta 1; Morocco 2; Tunisia 2; Turkey 2) beneficiaries of the RAP. The themes for each course were defined in accordance with the overall and specific objectives of the RAP-WRM and in cooperation and agreement with the regional partners taking into consideration:

- the whole set of priority actions for water saving in the Mediterranean region as it has adopted in the logical framework - the course's themes were discussed recurrently and included the priority activities of national partners institutions,
- specific interest of the countries hosting the course,
- recommendations of Technical Working Group (TWG), and
- thematic link among proposed topics and among them and collaborative research networks and overall RAP objectives.

The course's topics endorsed the most important subjects for the implementation of water saving strategies in the Mediterranean agriculture (e.g. agricultural water demand management, use of non-conventional water resources in irrigation, water use efficiency and water productivity, etc.) while introducing new modeling tools and information technologies (e.g. Geographical Information Systems, crop growth modeling, water distribution modeling, etc.). The themes of the courses have evoked the multidisciplinary approaches and they were strongly linked to the network activities of RAP-WRM which has affirmed the networks themselves and reinforced and enlarged their impact in the Mediterranean region. The emphasis was given not only

to the technical aspects, but equally so, to social, economical and environmental aspects, the major components of integrated water resources management approach. Particular attention has been given to the capacity to create arrangements for, and launch a process towards, integrated water resources management (IWRM) as a basis for competition resolution and capacity for dealing effectively and efficiently with the complex water challenges considering broad socio-economic, environmental and political contents. Furthermore, the courses have offered a practical technical program at the experimental fields, laboratory work and computer exercises. The discussion sessions, round-tables, and workshops organized within the frame of the courses with the local water authorities highlighted clearly weak points (nodes) of local water management strategies and helped to identify priority actions and programs for implementation.

The advanced short courses have generated high interest in the Mediterranean region. A total number of 709 candidates applied for admission to the courses, among them, (347) were selected to follow the courses. The participants in the courses belong to 15 Mediterranean countries and 3 other countries as illustrated in Figure 3. 318 participants (or 91.6%) belong to the beneficiary countries of the RAP.

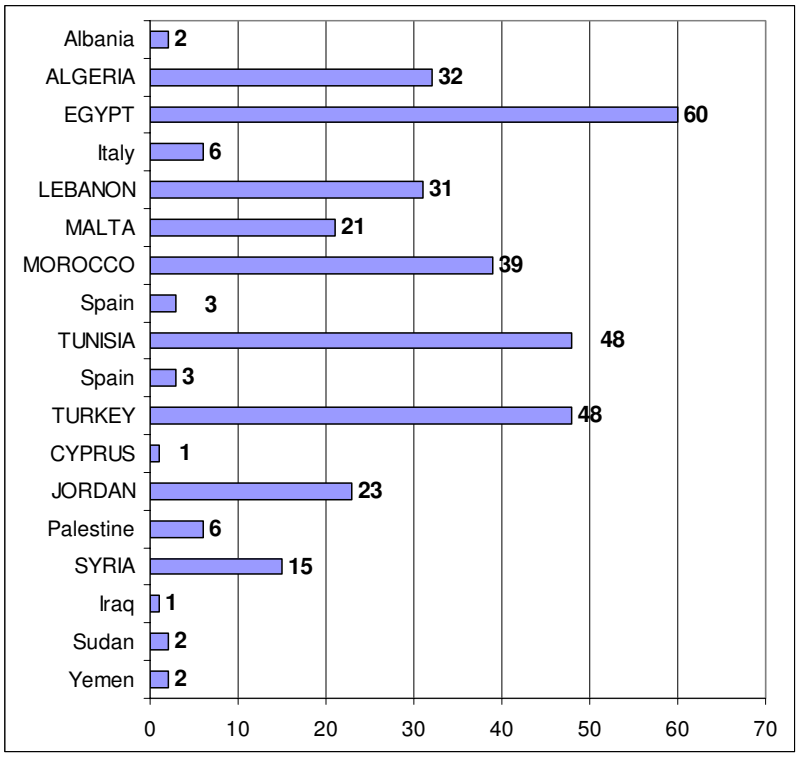

Fig. 3. RAP-WRM advanced short courses: participants per country (N.B. The countries beneficiaries of the program are written in capital letters)

The profile of the course's participants ranges from researchers and university assistants to water and irrigation engineers, rural development managers and governmental officers, as well as the representatives of the private sector (Figure 4). Practically, the courses provide "training of trainers" of different profiles which should induce multiplier effects in the future.

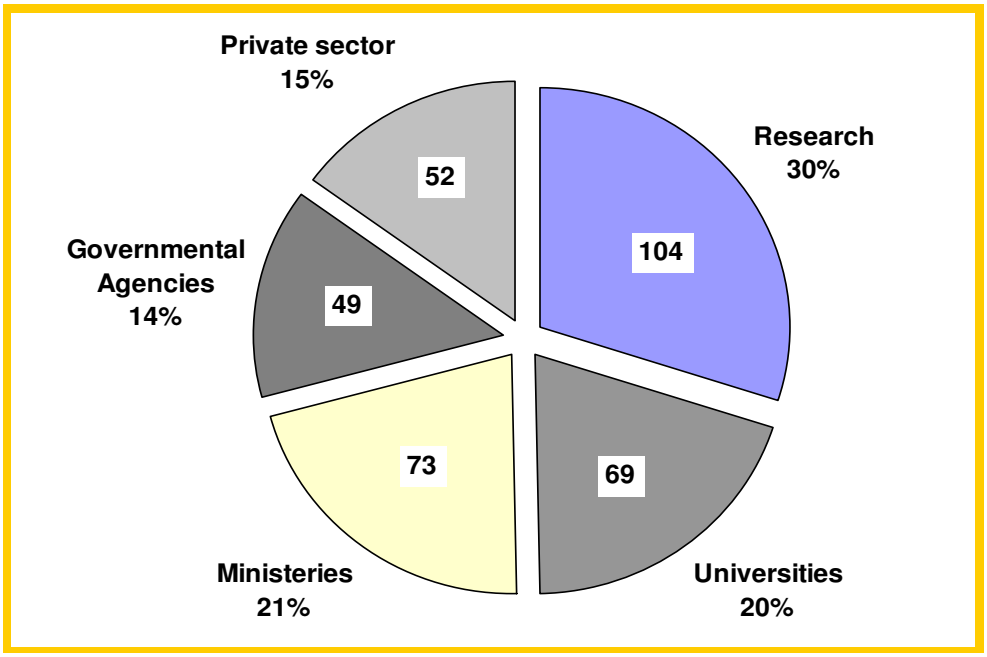

Fig. 4. RAP-WRM advanced short courses: professional profile of the participants

The proceedings of the courses, prepared and distributed to the participants at the beginning of each course, consist of a complete documentation related to the course themes. High interest was expressed to the proceedings and they were distributed on request in more than 100 copies per course also to local scientific institutions and to some regional and international organizations (e.g. FAO, ICARDA, IFAD).

MSc Mobility Programme

Mobility of trainees in MSc programme plays an important role in the improvement of cooperation not only between Southern and Northern Mediterranean universities and scientific institutions but also among the Southern Mediterranean institutions themselves. The emphasis is given to the cooperation between South-South scientific institutions, and thereby allowing the candidates to work under local conditions on some of concrete problems already existing in their countries of origin and highly related to the RAP program research activities. This type of cooperation allowed for exchange of researchers and, therefore, ideas

which helped in development of better water management strategies and transfer and integration of local approaches into actions at the regional scale. The mobility programme was carried out by Bari Institute with the involvement of twelve eminent Mediterranean Institutions from Egypt (National Water Research Center - Cairo; Central Laboratory for Environmental Quality Monitoring - Kanater; Drainage Research Institute - Cairo), Italy (University of Catania; University of Trieste; National Research Center - CNR, Bari; Polytechnics of Bari), Lebanon (Saint-Esprit de Kaslik University, Beirut; ESIAM, Tamail), Morocco (IAV Hassan II, Agadir), Tunisia (INAT, Tunis) and Turkey (Cukurova University, Adana). Research hosting institutions and research topics included in the mobility scholarship program were selected to fit into RAP research program and network activities and to improve the cooperation in the Mediterranean region.

The programme covered 19 trainees from 6 beneficiary countries (Algeria 1, Egypt 6, Lebanon 2, Morocco 4, Tunisia 3, Turkey 1) and Palestine (2), which is in agreement with the logical framework indicating a minimum of 16 Master thesis.

The mobility of trainees resulted in reinforcement of cooperation between Southern scientific institutions (e.g. IAV Hassan II, Morocco and INAT, Tunisia) and establishment of cooperation between Southern and Northern Institutions (e.g NWRC, Cairo, Egypt and University of Trieste and University of Catania). Furthermore, the mobility program contributed in the recognition of the MSc degree awarded by CIHEAM-IAMB in the majority of the Mediterranean countries and, also, in promoting the mutual recognition of diplomas obtained at different universities and scientific institutions throughout the Mediterranean region.

Cooperative research networks

The main objective of the "Water Resources Management" Collaborative Research Network is to provide scientific and technological know-how for investigated issues of water saving in the Mediterranean irrigated agriculture and, in such a way, contribute in improvement of human resources development and institutional capacity building in the region. Specific objectives are related to three Sub-networks of RAP-WRM (Figure 5)

- Non-conventional Water Resources Management (NWRM);
- Water Use Efficiency (WUE); and

- Collective Irrigation Systems (CIS);

  which, respectively, aims to promote:

- sustainable use of non-conventional water resources, including brackish and treated wastewater and re-cycled drainage water;

- increased crop water use efficiency and productivity in irrigation - more crop per drop;

- improved water distribution management and performances of irrigation systems.

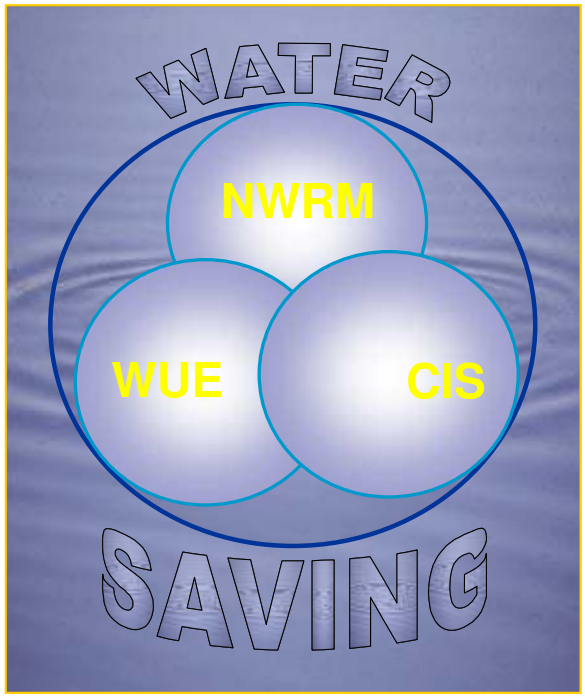

Fig. 5. "Water Resources Management" Collaborative Research Network: an integrated approach for water saving in irrigation agriculture

The research activities for each sub-network were planned in agreement to the specific objectives of each research theme and following the general and specific objectives of the Logical Framework of RAP on "Water Resources Management". Four major lines of interventions are agreed with the network's members in order to alleviate some priority problems of Southern Mediterranean countries and to contribute strongly to the realization of the overall RAP objectives:

i. development of human resources qualified and knowledgeable in understanding the basics of the network domains, using the data

base information system and operating the information technology platform;

ii. carrying out specific research works to fill in gaps in scientific information within the domains of interest;

iii. realization of database information systems on each network domain;

iv. implementation of an information technology platform for analysis, elaboration and interpretation of agricultural scenarios.

These Sub-Networks were already established before the RAP started and they represent the continuity with previous EU-CIHEAM programs, based on the priority issues of water management under scarcity conditions in the Southern Mediterranean countries, i.e. necessity for water saving in irrigated agriculture. During the Phase I of RAP (1998-2000), it was planned that the three sub-networks should act as three parallel research lines and in the second phase of RAP (2000-2002) they have to be integrated within one umbrella of research project WASIA to facilitate exchange of information and strengthen new strategies for water management in the region.

Consequently, the NWRM-Net was engaged in water quality issues, the WUE-Net was engaged in water use efficiency issues and the CIS-Net was engaged in performance analysis of collective irrigation systems. They all integrated and exchange their approaches under the "Water Resources Management" Collaborative Network. The integration of Sub-Networks into an overall "Water Resources Management" Collaborative Network should denote the “soul” of RAP promoting, designing, generating, integrating, expanding and intensifying all other actions of RAP such as training and mobility, aid to decision making, workshops and seminars.

Networking – overall results (RAP – Phase I)

The overall results and outputs of the activities carried out within the all three sub-networks of the RAP-WRM in the period 1998-2002 can be summarized as:

- the involvement of 32 scientific institutions from 15 countries (among them all 10 countries beneficiaries of the RAP) with the participation of 66 scientists;

- experimental work has been carried out not only at the experimental fields, lysimeters and greenhouse of IAMB but

also at the experimental sites in Morocco (IAV Hassan II, Agadir), Egypt (NWRC, Cairo), Syria (ICARDA, Aleppo), Tunisia (INAT, Tunis; IRESA, Bizerte), Turkey (Gaziantep Pistachio Research Institute), Italy (Faculty of Agriculture, Catania; Bonifica della Capitanata, Foggia), etc.;

- a Crop Database containing information about 8 Mediterranean strategic crops was developed together with a crop growth and productivity model and an interface linking the crop growth and productivity model and the Geographical Information System (GIS);

- a database on the performances of collective irrigation systems was developed together with a user friendly software package for the analysis of collective irrigation systems and demand hydrograph generation;

- one Information Manual on the software package was published;

- guidelines for the use of treated sewage water in agriculture has been prepared and published

- 68 MSc students from 9 countries (Algeria 4; Bosnia and Herzegovina 1; Egypt 15; Lebanon 12; Morocco 14; Palestine 5; Syria 1; Tunisia 11; Turkey 5) were completed their MSc work on the topics of the Network and under the supervision of the members of the Network

- 12 advanced short courses were organized with the participation of 347 trainees from 18 countries - more than 100 copies of proceedings are distributed in the occasion of each course

- 131 scientific papers were published in scientific journals and proceedings of conferences, workshops, advanced short courses, etc.

- three books and 24 special publications are also published.

Research activities have contributed for enhancement of cooperation not only with the national research institutes but also with some international organizations (FAO, ICARDA, IFAD) which have provided opportunities for expanding the action programs. For example, the NWRM-Network is one of the members of IPTRID (the

International Program for Technology and Research in Irrigation and Drainage) Network - working actively with other IPTRID networking organizations and institutions (FAO, ICID, CEMAGREF, ILRI, HRW and IWMI). Also, the WUE-Network has established a concrete cooperation with the FAO in the field of water use efficiency and crop water requirements, through the exchange of information in this fields and the presence of Bari Institute, as observer, in the scientific meetings held by the FAO. Furthermore, the importance of the research results of CIS-Net have yielded in the joint publication of the FAO Irrigation and Drainage Paper N°59. The network activities are interconnected also with a series of other initiatives in the region including the Global Water Partnership - MED Network which has water saving in the Mediterranean countries as one of its primary objectives.

Whenever possible, the Research networks tried to mobilize the private sector to cope with certain problems which are of importance in water resources development and management. A successful example of this is the CIS-Net which, in cooperation with private companies, developed a new technology to improve irrigation management through automation system (AcquaCard), which is now introduced in several irrigation projects in Morocco and Tunisia.

The collaborative research networks will be continued on the base of voluntary participation of researchers and scientific institutions and universities. Several Research Projects were submitted and financed beyond the RAP to allow sustainability of network research activities. Among them, the EU project "BIOWATSYST - a system approach to wastewater biotreatment for the protection of Mediterranean coastal areas" is of particular importance since it was conducted within the frame of NWRM-Net with the participation of partners from six Mediterranean area (Spain, Italy, Greece, Jordan, Egypt, Morocco).

Research Project WASIA (Water Saving in Irrigated Agriculture)

The research project WASIA has been developed during the second phase of the RAP (2000-2002) when it was necessary to transfer some of research findings on the ground in Mediterranean environment. The main objective of the WASIA research project is to develop a conceptual framework for water saving in irrigated agriculture of the Mediterranean region through the integration of the activities which represent major topics of the three Collaborative "Water Resources Management" Research Networks and aim to:

- Improve water use efficiency in irrigation practices (WUE_Net),

- Improve performances of irrigation distribution systems (CIS_Net), and

- Promote safe and sustainable use of non-conventional water resources (NWRM_Net),

- Specific objectives of the project were addressed to the development of 8 (eight) research themes to be carried out at eight different locations in the Mediterranean Region:

    1. Deficit Irrigation of orchards with low quality water, (Tunis, Tunisia)

    2. Deficit Irrigation of pistachio with different fertigation practices (Southeast Anatolian Region, Turkey)

    3. Hydraulics performances of irrigation systems under different irrigation practices (Ghezala-Teskraya, Tunisia)

    4. Innovative approach for energy saving in irrigation systems (Souss Massa, Morocco)

    5. Reuse of treated wastewater for irrigation of cereals, forage and vegetables by means of different irrigation methods (Agadir, Morocco)

    6. Re-cycling of drainage water for sustainable irrigated agriculture (Nile Delta, Egypt)

    7. Sustainable use of highly saline water for irrigation of crops under arid and semi-arid conditions: new strategies (Tarsus, Turkey)

    8. Development of screening legumes and forage nursery for salinity tolerance (Aleppo, Syria)

Those research themes covered some of the most important aspect of water saving in the Mediterranean agriculture and represented the continuation of the collaborative research network activities carried out during the first phase of the RAP.

A detailed presentation of the activities carried out under this project, the results and the research findings are given in: www.iamb.it/par/

Logistic Support/ICT Activities

The Logistic Support/Information and Communication Technology (ICT) actions aimed at the implementation of an Internet-based "Information System" to promote exchange and dissemination of scientific and technical information in the Mediterranean region. This system has to contribute to the establishment of a permanent co-operation network between Mediterranean institutions committed to develop training and research on "Water Resources Management". For such reasons, the financial resources have been allocated to upgrade scientific equipment, hardware and software in the countries beneficiaries of the program and, in such a way, to contribute in the improvement of human resources development and institutional capacity building in the Mediterranean irrigated agriculture.

In the first year of the project (1998-1999), the following activities have been carried out:

- Installation of a web server at the National Water Research Center (Cairo, Egypt);
- Supply of 2 internet workstations to the IAV Hassan II – Centre Horticole (Agadir, Morocco);
- Supply of an info-network to Lebanese Agricultural Research Institute (LARI) (Bekaa valley, Lebanon).

The activities are not only limiting in providing the needed equipments but included some specific training courses. In Tunisia 4 short courses on the use of new information technologies, multimedia and distance learning were organized. Training has been mainly focused on the people charged with the management of the ICT and documentation facilities in the collaborating institutions while only 25% of trainees belonged to research sector (Figure 6). Furthermore, a workshop on "Meta-information system for Mediterranean region" was organized in Bari in 2000 with the participation of the persons involved in other RAP sub-projects developed by other CIHEAM Institutes. Moreover, training and cooperation activities have included also the participation on several workshops organized by other Institutions.

The RAP-WRM web site has been developed in both English and French and it is available at URL: http://www.iamb.it/par/. The web-site's structure encompasses the main project's objectives and activities and it is consistent with the other CIHEAM RAP web-sites. On the home page of the RAP – WRM web site, a search engine enables the searching on the site with keywords and an e-mail link allow the

visitors to send questions or comments. The site contains also the link to all partners participating in the program and to the WASIA research project. The RAP-WRM web is the project's general container of all detailed information and documentation sources and its role is not only the exchange of data among the partners in the RAP but also dissemination of information among all stakeholders involved in water sector in the Mediterranean region. In fact, the web-site has a role of information gateway among the partners and it represents an important data bank (of bibliographic data and research results) for scientific users. The updating of web-site is ensured by the CIHEAM-IAMB webmaster through an efficient information retrieval system agreed by all project's partners and actors.

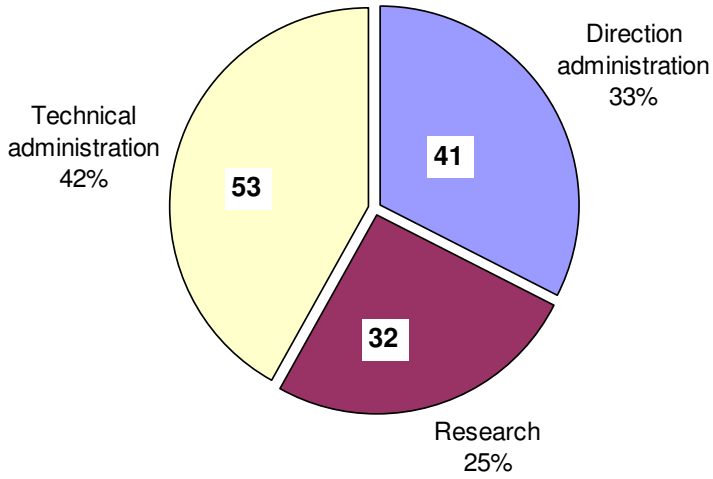

Fig. 6. Logistic Support/ICT training activities: professional profile of the participants

Aid to Decision Making

The aim of this action of the RAP-WRM is to give to decision makers guidelines and strategies for implementing new social and economic reforms in the irrigation sector via appropriate measures such as participatory irrigation management, water valuation and cost recovery, water allocation efficiency, etc. Consequently, two sub-programs have been developed:

- Sub-Program I: Participatory Irrigation Management (PIM) and Water User Associations (WUAs)

- Sub-Program II: Economic Aspects of Water Mobilization and Use

Participatory Irrigation Management (PIM) and Water User Associations (WUAs)

The overall objective of this program is to stimulate high level policy dialogue on Participatory Irrigation Management in the Mediterranean region leading to a policy commitment programming actions with the specific objectives to introduce policy-makers to the implementation of PIM, learn about best practices from other countries to select the most appropriate corresponding to the socio-economic situation of the majority of the developing countries in the region, and, as a pre-step, to formulate indicative action plan for enhancing participation in irrigation sector. These objectives were achieved through the exchange of experience and information during the training courses conducted annually at Bari Institute.

Three training of trainees (TOT) courses on "Capacity Building for Participatory Irrigation Management" were carried out at the IAMB in 1999, 2000 and 2001, in cooperation with the Economic Development Institute (EDI) of the World Bank, IFAD (International Fund for Agricultural Development) and INPIM (International Network on Participatory Irrigation Management). The CIHEAM/IAMB and the World Bank have started the cooperation on PIM in 1997 and the RAP-WRM courses on "Capacity building for Participatory Irrigation Management" have become a part of this cooperation since 1999.The program of the courses was composed of lectures, brain-storming workshops, discussion sessions and technical visits to the "Consorzio Bonifica Capitanata" offering to the participants a possibility to exchange the experiences with both technical and administrative staff of Consortia and farmers.

A total number of 209 candidates applied for the participation on three courses which confirms the importance of the subject for water saving and management especially in irrigated agriculture. 142 trainees from 20 countries not only from the Mediterranean region but also from some Asian and African countries were selected to follow the courses. Among them, 83 (or 58.4%) were from 7 Mediterranean countries beneficiaries of the RAP (Algeria 3; Egypt 27; Jordan 3; Morocco 8; Syria 4; Tunisia 21; Turkey 17).

The proceedings of the courses, distributed to the participants and, on request, also to many governmental agencies and international organizations, contained five volumes of the complete PIM program including: Handbook on PIM, PIM Case Studies, Country overviews of PIM, PIM in the Mediterranean countries and The Experience of Consortia in Italy.

These courses have resulted in an increasing number of trained people on the national level, improving the local institutional capacity building and enhanced the irrigation management transfer process in many of the developing countries in the Mediterranean and other developing regions of the world. An analysis of the outputs and impacts of the activities on PIM realized in the period 1998-2002, indicated several important points:

- a gradual increment, from year to year, in the number of candidatures and participants in the PIM courses is a strong indicator of the attractiveness and interest on the proposed program and its wide dissemination in the Mediterranean and other regions of the world (Figure 7);

- high interest of the national governments of the developing countries in the running courses - it is the unique program where governments ask for the participation of additional number of candidates more than those officially accepted for the attendance of the course with full coverage of their expenses;

- many participants came from the PIM Projects supported by the USAID in the region, as well as those supported by the International Organizations (FAO, World Bank, IFAD) with a complete coverage of the expenses of their participants;

- on the request, within the frame of other programs developed by the World Bank, additional special training programs were organized for experts from Kirgyzstan and Uzbekistan in Italy;

- the PIM Program of Bari Institute has been presented as a model for implementation in several African countries during the "National Conference on Irrigation" organized by FAO in cooperation with the Ministry of Agriculture and Food Security of Tanzania in 2001, where Bari Institute presented a keynote-paper titled: "Participatory Irrigation Management: Experiences, Gained Benefits and Arising Problems";

- in cooperation with IFAD, Bari Institute is acting as the implementation agency for PIM in Egypt, Morocco and Tunisia. This program has started at the beginning of 2002 and it will last for four years, with a total budget of US$ 1,680,000.

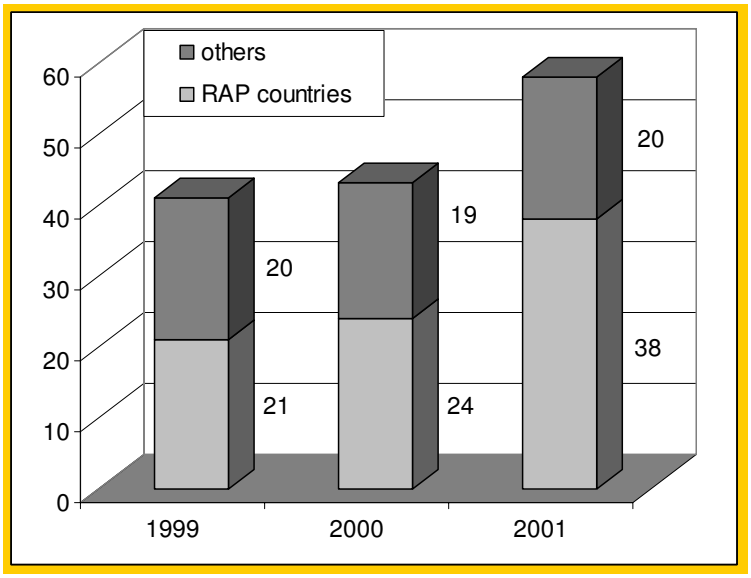

Fig. 7. Evaluation of the number of participants on the PIM courses 1999-2001

Economic Aspects of Water Mobilization and Use

The objective of this program was to give to decision-makers in the Mediterranean region, the opportunity to present, share and discuss various experiences relevant to the subject and to elaborate strategies and plans of actions for implementation of measures which could lead to a better valuation of irrigation water and appropriate cost recovery mechanisms. Furthermore, this program includes also the role of gender in the management of water resources in the Mediterranean and the involvement of women experts working in water sector. Accordingly, two Workshops have been organized:

- a workshop on “Water valuation and cost recovery mechanisms in the developing countries of the Mediterranean region” , and
- a workshop on "Gender and water resources management in the Mediterranean".

Water Valuation and Cost Recovery Mechanisms

A workshop on this topic was held in June 2002 in Agadir (Morocco), as a special session of the International conference on "Irrigation water policies – micro and macro considerations”. The Conference was followed by more than 200 experts mainly from the Mediterranean region. Participated actively in the workshop 14 decision makers, engineers and economists from 8 beneficiary countries (Algeria 1,

Cyprus 1, Egypt 1, Jordan 1, Malta 1, Morocco 3, Tunisia 1 and Turkey 1), Arab Organization for Agricultural Development (1) and CIHEAM-IAMB (3). The decision makers from the Mediterranean countries underlined the importance of this workshop which gave them the opportunity to present, share and discuss various experiences relevant to the subject, and to elaborate strategies and plans of actions for the implementation of measures which could lead to a better valuation of irrigation water. Moreover, the participants of this session highly recommended the establishment of a network on "Water valuation and cost recovery mechanisms in the developing countries of the Mediterranean" as an appropriate approach to bring together the experiences in this field and to set viable strategies for implementation in the region.

The papers presented during the Special session on "Water Valuation and Cost Recovery Mechanisms in the Developing Countries of the Mediterranean Region" were included in the Proceedings of the Conference which was distributed to more than 200 participants of this important event. In addition, all contributions are published in a special volume of "Options méditerranéennes" (Hamdy *et al.*, 2002).

The recommendations from the Workshop on "Water valuation and cost recovery mechanisms" may be synthesized as the following:

- Irrigation policies should play a regulatory role with regard to objectives of equity, natural resources protection and water market creation;

- Tariffs will not be an effective tool for economizing on water as long as they do not relate available water volumes to irrigation water prices;

- Irrigation water tariff and recovery policies should aim to guarantee irrigation infrastructure maintenance and replacement, and, simultaneously, ensure sound water services for agricultural uses;

- Tariffs should have social, economic, political and environmental objectives and consequences;

- The application of irrigation water tariffs and charge recovery policies should take into consideration the local, regional and/or national and socio-economic conditions, as well as the macro-economic orientations of irrigation development. Water prices should integrate the elements adapted to the specific

context of irrigation projects, simultaneously ensuring agricultural development, risk aversion and water saving.

Gender and water resources management

This topic was fully covered on a workshop held on October 12-14, 2002, in Cairo (Egypt), as a special session of the First Regional Conference on "Perspectives of Arab Water Cooperation: Challenges, Constraints and Opportunities". The Workshop was attended by more than 100 participants covering most of developing Mediterranean countries and representatives from different Arab countries, national, regional and international institutions, NGOs and several women organizations. 17 experts from all the beneficiary countries of the RAP (Algeria 1; Cyprus 1; Egypt 2; Jordan 2; Lebanon 1; Malta 1; Morocco 1; Syria 2; Tunisia 2; Turkey 2) and Italy (2) have contributed in the Workshop. The contributions to the session are published as a special volume (El-Kady and Hamdy, 2002) and included the case studies related to the experiences on the gender issues from each of 10 beneficiary countries of the RAP.

The challenges for the future are identified to overcome the considerable gap between positive policy intentions to concrete action as well as to improve the current body of knowledge on gender and irrigation. Among them, the participation, information and consultation are basic elements for gender development and implementation. In the region, there is an urgent need for the establishment of a network to put together the local institutions, NGOs, stakeholders and water user associations working on gender issues to gather the scattered information in this field and to set and formulate policies, strategies and implementation methodologies in view of social, cultural as well as religion conditions on both national and regional level.

- This workshop had a very high impact in the Mediterranean countries since it was organized as a special session of an important regional event with the participation of decision makers and experts from the whole region and with full involvement of local governments and institutions. The importance of the topic and the necessity for exchange of experiences from different Mediterranean countries was recognized by all participants. After detailed discussion and debate, the participants of the workshop on "Gender and water resources management in the Mediterranean region" came up with the following recommendation to be taken as an aid for decision makers:

- In the Mediterranean region, there is an increasing recognition that irrigation is a crucial part of the broader movement of gender mainstreaming in agricultural and rural development, and, indeed, seriously considered by a wide array of people from grassroots women's organizations to international development and financing agencies.

- Case studies and experiences presented in the workshop highlight that thanking to the changes in cultural trends, women labor forces are growing in number, yet, the accumulated knowledge from presented case studies and experiences achieved did not give the appropriate insight that could effectively guide the policy and interventions.

- In the developing countries of the region, the slow conversion of gender policies into practice, in particular in water resources management and irrigation, are the resultant of the followings:

    - The lack of analytical tools and appropriate concepts;

    - The lack of generic conceptual framework and appropriate implementation methodologies, beside the absence of gender performance indicators and above all the vague and week roles of irrigation institutions and agencies.

Conclusions

The Regional Action Program on "Water Resources Management" represents one of the biggest activities ever carried out by the Mediterranean Agronomic Institute of Bari. Thirty national institutions and Universities from 10 beneficiary countries, 7 Italian partners and 5 International organizations (FAO, Rome; ICARDA, Aleppo; IFAD, Rome; World Bank, Washington and INPIM, Washignton) have been involved directly in the program along with about 1105 persons from 31 countries around the world.

The relevance of the main topics treated within the programme and related to the water problems in the Mediterranean irrigated agriculture has been confirmed by the fact that 1026 (or 92.9%) participants were from the Mediterranean region, while 887 (or 80.3%) were from 10 Mediterranean countries, beneficiaries of the RAP.

The activities within the RAP-WRM have produced 19 short-term courses, tens of experimental works and 68 MSc theses, 19 mobility MSc programmes, research works at seven pilot locations in the Mediterranean, two important workshops, numerous meetings and

reports, 131 scientific papers, several research manuals, guidelines and databases, 24 special publications, 3 books, etc. These activities have been developed in agreement with RAP programs and activities of other CIHEAM Institutes. The adoption of such approach gave the possibility to manage the activities within different RAP themes in a complementary way respecting the major necessities of each beneficiary country in the water resources management and agricultural sector. Certainly, this methodology, considering different aspects of water management in Mediterranean agriculture, has supported substantially the institutional capacity building process and human resources development in the beneficiary countries of the RAP. This is confirmed through the valuation of the progress reports and evaluation sheets of the training program of RAP-WRM.

Furthermore, this program is not confined to itself, but it gave the opportunity to add durable values to the overall training, research and cooperation that CIHEAM is promoting in the Mediterranean region. In fact, the activities carried out within the frame of the Water Resources Management Network have contributed in the generation of new programmes and in the establishment of two ample thematic networks: one on land management (MEDCOASTLAND) and other on water management (WASAMED). Both programmes are gathering around 78 institutions representing 16 countries in the Mediterranean region. The running activities in both networks are linked and completing each other. The exchange of information and its dissemination will enable in setting the appropriate strategies leading to a sustainable use and management of natural resources - land and water. Certainly, this new projects have attributed an added value to the RAP-WRM and do represent the sustainability and continuity of the programme.

In the RAP-WRM major emphasis has been given to the socio-economic aspects under Aid for Decision Making programme including the following crucial issues:

- Participatory irrigation management
- Water valuation and cost recovery mechanisms, and
- Water resources management and gender issues.

The workshops, the training programmes, the issued publications and proceedings all helped in giving vast information characterizing the actual situation, the constraints and came up with a series of recommendations including specific actions and approaches for the promotion of activities within each of the above mentioned issues. The

activities carried out in these programmes were of influential impact on the local, regional and international level and attributed in:

- Increasing the awareness of the decision makers and politicians with a better understanding of the surrounding problems in the water sector;

- Providing the decision makers and the technical staff involved in this sector with aiding guidelines, helpful in the formulation of actions and strategies appropriate to the existing local conditions;

- The attraction of several International Organizations (FAO, IFAD, World Bank, INPIM) not only through their cooperation in sharing the activities, but also their input in new programmes for the sustainability and continuity of RAP-WRM programme such as:

    - A four-year programme for the implementation of PIM in some developing countries of the Mediterranean (Egypt, Morocco, Tunisia) in cooperation with IFAD;

    - A one-year programme on gender and water resources management, financed by EU, in collaboration with the NWRC-Egypt as a partner to initiate a thematic network dealing with this issue;

    - The creation of a very fertile atmosphere for a world wide exchange of experience, transfer of knowledge and cooperation.

In the RAP-WRM the principal partner was the National Water Research Center - NWRC (Cairo, Egypt) being a center of excellence dealing with water resources development and management in Egypt and also involved in numerous technical and research programmes and projects with several international organizations and several European, Mediterranean and African countries. The contribution of NWRC with Bari Institute in developing the whole programme with its numerous activities facilitated the job of the Institute in coordinating the programme, creating a very tight cooperation link between the institutions in the Mediterranean and for first time a realistic cooperation existed between South-South and South-North of the Mediterranean. In addition, such cooperation pushed forward the decentralization approach, one of the main objectives the RAP was heading to. Such model of cooperation through the RAP-WRM created

a realistic trust conditions and expanded the cycle of cooperation to cover beside the water resources other different sectors dealing with agricultural and rural development. In cooperation with the Ministry of Agriculture, CIHEAM-IAMB is involved in the development of several programmes in plant protection, organic farming and rural development. This holds also true for other several cooperative programmes with both Ministries of water resources and environment as well as other local governments. Such programmes not only created new links of cooperation between CIHEAM-IAMB and other scientific institutions and universities, but above all enabled in building a solid bridge for cooperation between the scientific institutions and scientists in the country.

Normally, the coordination and realization of such programmes addressed to a relatively high number of beneficial countries and including many different activities is not an easy process and always a subject to several problems and constraints during the running of the programme. This was not the case with us thanks to the serious involvement deep understanding and high cooperation of our partner in the programme: the National Water Research Center (NWRC), Cairo, Egypt, and the effective and engagement of the ten beneficiary countries in running the programmes with all its components. Indeed, the success of the programme is not only due to its scientific achievements, but, and above all, to its role in strengthening the trust, the respectful conditions and the cooperation between CIHEAM – IAM Bari Institute and the involved partners and within the beneficial countries of the programme.

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