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THE INTEGRATION OF SOIL AND WATER RESOURCES MANAGEMENT TOWARDS A SUSTAINABLE AGRICULTURAL DEVELOPMENT IN THE MEDITERRANEAN

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Introduction

The notion of sustainability implies a central concern with the welfare of people, now and in the future, through increased productivity, for which the conservation and improvement in the quality of natural resources and the environment are the necessary conditions.

"Sustainable development" has become more than a catch phrase since 1987, when the World Water Commission on Environment and Development (the Brundtland Commission) published its report, "Our common future". The growing concern with both meeting the interdependence and changing needs of people at the same time maintaining harmony with their natural resources and environment has started to yield concrete actions at national and international levels. It has also become evident that the issue of development and environment are contentious. The world summit on "Environment and Development" in Brazil (1992) and the World Development Report (1992) of The World Bank provided further evidence of the increased sensitivity to, and the difficult policy choices for, sustainable development at global, regional and national levels.

The concept of "Sustainable Development" is inherently holistic: it implies long-term perspective for planning and integrated policies for implementation. As such its relationship to human welfare should take into account five basic dimensions:

- *environmental*: maintaining the integrity of the bio-ecosystem in relation to human populations;
- *economic*: increased efficiency in production and equity in the distribution of resources and income;
- *cultural*: sensitivity to the values and traditions of each society;
- *social*: participatory development, including gender equality, with equitable access to social services and employment opportunities; and
- *political*: empowerment, good governance, and protection of basic rights.

In the context of developing countries, the major challenge is to achieve and maintain a sustainable agriculture when agriculture is still the dominant sector of economy. This challenge takes on a special meaning in the developing countries of the Mediterranean, many of which are undergoing a painful experiment in "structural adjustment" to achieve sustainable development. Those countries are facing the dual challenge of making structural adjustments in the short to medium term, and trying to develop a sustainable agriculture in the long run.

Sustainability and agriculture

Sustainable development is an issue, which has exercised the public mind for some years, even if few have a clear understanding about it. At one level, it is one of those fuzzy ideas that everyone is in favour of, because it means all things to all people. At another, it has a concise description: it is about taking better care of the environment while ensuring economic growth. It is where ecology meets economics.

There are many definitions of sustainable development. The World Commission on Environment and Development (1987), defined sustainable development as *"development that meets the needs of the present without jeopardising the ability of future generations to meet their needs".*

Applying this notion of sustainability to agriculture, one of the Commission's panels stated that *"Enduring food security will depend on a sustainable and productive resource base".* The challenge facing governments and producers is to increase agricultural productivity and thus ensure food security, while enhancing the productive capacity of this natural resource base in a sustainable manner. The panel expressed this challenge in these words: *"the next few decades present a greater challenge to the world food systems than they ever face again".* The efforts to increase production in pace with unprecedented increase in demand, while retaining the essential ecological integrity of food systems, is colossal, both in its magnitude and complexity. Given the obstacles to be overcome most of them man-made- it can fail more easily than it can succeed.

The need to increase agricultural productivity as emphasised by Brundtland Commission is often grossly neglected by many of those addressing the sustainability issue. They tend to place primary emphasis upon the environmental or natural resource degradation issues - which are indeed very important issues- but essentially ignore the need for greater agricultural output.

According to the FAO (1990), in the context of agriculture, forestry and fisheries, "sustainable development is the management and conservation of natural resource base and the orientation and technological change to ensure the attainment and continued satisfaction of human needs: food, water, shelter, clothing and fuel for present and future generations". Such sustainable development, including agriculture, forestry and fisheries conserves genetic resources, land and water resources, is environmentally non-degrading, is technically appropriate, is economically viable and socially acceptable.

The United Nations Technical Advisory Committee (TAC) for the Consultative Group on International Agricultural Research (CGIAR) succinctly described sustainable development (TAC, 1992a and b) as: "successful management of resources for agriculture to satisfy changing human needs while maintaining or enhancing the quality of the environment and conserving natural resources".

Walsh (1991), further emphasised that since population growth is greatest in developing countries: "agriculture, therefore, will be facing a double challenge - not simply to increase food production, but to assure that the resource base is not neglected". Abernethy (1992) added that since sustainable refers to the future, a discussion of sustainability also means forecasting for future.

Examining the previously sustainable definitions, it is quite clear that the concept of sustainable development implies a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are all in harmony and enhance both current and future potential, to meet human needs and aspirations.

Agriculture in the Mediterranean: development and sustainability

The Mediterranean countries and, in particular, the developing ones are poorly endowed with two critical natural resources: productive land and accessible, renewable water resources.

Land resources and land use

Land use and distribution of agricultural land areas are illustrated in Figure 1. The extent of soils grown with respect to the total area of the countries is always below 50% in the Mediterranean and even below 10% in some countries (i.e. Algeria, Libya, Egypt) where the total land area mostly consists of desert.

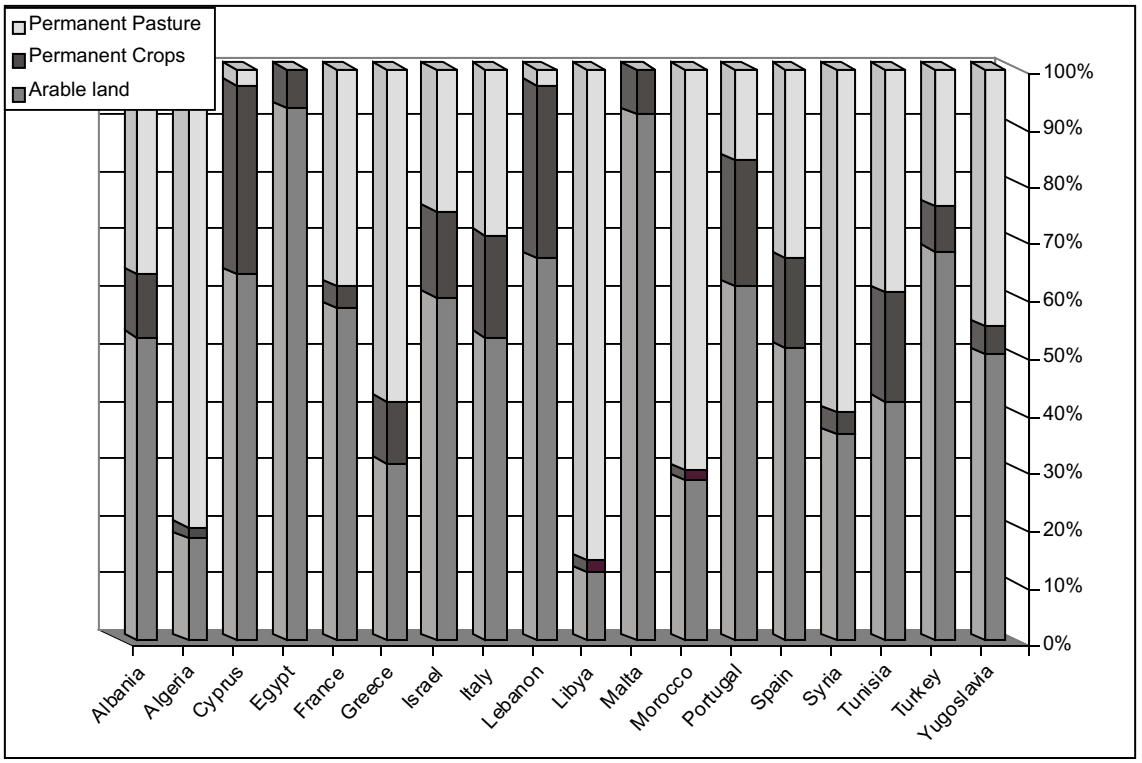


Figure 1. Distribution of land use areas in the Mediterranean countries (Source: FAO, 1993)

For a total area of about 850 million hectares, 125 millions - less than 15% - are arable land and land under permanent crops. As a result, human settlements have been concentrated on a relatively small part of the landmass and food production has depended heavily on irrigated agriculture.

Pastures present several hundred million hectares, suitable for extensive animal breeding with great possibility of a relatively high animal production through a proper and better management.

There are great differences in the region in regard to the land use between one country and another, and this holds true among the Southern, Northern and Eastern Mediterranean regions (Table 1).

Table 1. Land use as percentage of cultivated area in the Mediterranean
(Source: Hamdy and Lacirignola, 1993)

Region	Annual crops %	Permanent crops %	Permanent pastures %
North	57.55	10.90	30.89
South	38.60	6.40	55.0
East	56.50	20.50	22.75
Average	50.88	12.60	36.22

Soil degradation

Land is a finite resource, while the natural resources it supports can vary over time, management conditions, and uses. Expanding human requirements and economic activities are placing ever increasing pressure on land resources, creating competition and conflicts and resulting in sub-optimal use of both soil and land source in the Mediterranean.

In arid and semi-arid regions, the uncontrolled utilisation of natural resources, exceeding the limit of ecological stability of natural eco-system, almost always results in degradation, which is often irreversible because appropriate care for the rehabilitation of affected lands is missing (FAO, 1981). The aspect that mainly affects the future capabilities of soil for agriculture is soil degradation. Erosion is the single largest threat to soil quality in the Mediterranean basin. Grenon and Batisse (1988) pointed out that more than 50% of agricultural soils are threatened by erosion in most of Mediterranean countries.

In Turkey, over 50% of agricultural land is threatened by erosion. In Maghreb countries, erosion is considered one of the major problems in cultivated land. Water erosion is the most serious threat to soil in the Mediterranean countries, resulting from both geological and human action.

In the Mediterranean region, 31% of land suffers losses from erosion, amounting to over 15 t/ha per annum. Overall, more than half of the land in watershed is prone to erosion. Accurate observations on watersheds, comparison between aerial photographs taken on successive dates, increasing speed of rising water during floods, all confirm that erosion phenomena is speeding up throughout the Mediterranean watersheds.

Desertification and salinisation

Among the adverse processes leading to the deterioration of land and the impoverishment of many nations of the region, desertification and salinisation are quite significant. The two

processes are different, but closely interrelated: progressive salinisation induces the development of desertification. In many areas, salinisation and desertification alternately induce each other with disastrous consequences.

Those are major alarming phenomena in arid countries of the region. Very serious problems are reported from Arab countries of North Africa, major Southern and Eastern Mediterranean countries and the Middle-East region. Egypt, Libya, Algeria, Morocco and Tunisia suffer from desertification and, particularly, from the salinisation of irrigated land. That is also the case in Turkey, Lebanon, Israel, Iraq and Jordan.

Aware of how desertification is dramatically affecting the agricultural production and the sustainable development in the arid regions, action plans and policy programmes have been established to combat it, but the progress is very limited and very far from the expectations underlined. Desertification is widespread and increasing, bringing more and more land out of production. Such worse situation is doubtless the result of the following:

- the policies that had been settled and/or the methods and approaches to be adopted and followed to combat desertification were not coherent to cope with local socio-economic conditions, difficult to implement and time consuming;
- the organisations and agencies in charge of applying the policies have neither sufficient funds and political support nor the qualified personnel to do the job;
- forestry policies on the use and conservation of natural renewable resources were not addressing all aspects of rural development and other problems of diminishing natural resources. In addition, the elusive compromise between achieving food self-sufficiency, while re-establishing an ecological balance has not been made and adhered within the policy framework.

To diminish land degradation in the Mediterranean region, and to combat desertification we are in need to formulate policies that fit the general development and resource management models for each country. This policy must not only be an element in planning and implementing rural development and resource conservation activities, but a common requisite reference and starting point that could define the technical, economic, social and political framework through which we can achieve the goals in slowing down the rapid land degradation and desertification process.

In this regard the UNCOD, held in Nairobi (1978), recommended that: “urgent measures need to be taken to combat desertification by preventing and controlling waterlogging, salinisation and sodication by modifying farming techniques to increase productivity in a regular sustained way, by developing new irrigation and drainage schemes where appropriate, always using integrated approach and through improvement of the soil, social and economic conditions of people dependent on agriculture”.

In the Mediterranean region, with the abandonment of agricultural land in the North, and a lower growth of agricultural areas in Southern and Eastern countries of the basin, the lack of an adequate management according to soil potentials, the inability to check soil erosion and degradation processes, the loss of agricultural land would remain a permanent problem which could worsen at any time.

Extent of agricultural salt problem

In arid and semi-arid countries of the Mediterranean, on irrigated land, improper water use and systems management not only prevent attainment of potentials but also cause productive land to be lost to cultivation through waterlogging and increasing salinity and sodicity. The net result is physical, chemical and biological degradation of land on a very large scale.

The World Bank reports that "Globally, nearly 950 million hectares, or nearly one third of arable land, are affected by elevated salt concentrations". According to the estimates of UN and affiliated organisations, more than half of all irrigated territories of the world are more or less salinised, alkalised or waterlogged due to improper methods of irrigation.

The use of waters of low quality, the saline one, also contributes to the process so called secondary salinisation, which is expanding in our days to an accelerated rate. The total territory of secondary salinised lands increases by more than 10 million hectares yearly and in several countries this results in serious economic problems.

Soil salinisation in the Mediterranean is among the main constraints for agriculture development and sustainability. Indeed, salt affected soils are now a serious problem when considering their relatively high percentage with respect to the irrigated ones in some countries of the region (Table 2).

Table 2. Estimates of percentage of irrigated land affected by salinisation in some Mediterranean countries.

Country	% affected	Country	% affected
Algeria	10 – 15	Jordan	16
Egypt	30 – 40	Portugal	10 - 15
Cyprus	25	Spain	10 – 15
Greece	10	Syria	30 – 35

Agriculture and water use

Nearly 70% of the available water resources in the Mediterranean region are allocated to agriculture. In the arid and semi-arid countries of the region as much as 80% of water used is devoted to agricultural production and development.

In the developed Northern countries less water is allocated for the agriculture sector and its share is about 50% of the whole available water resources (Figure.2).

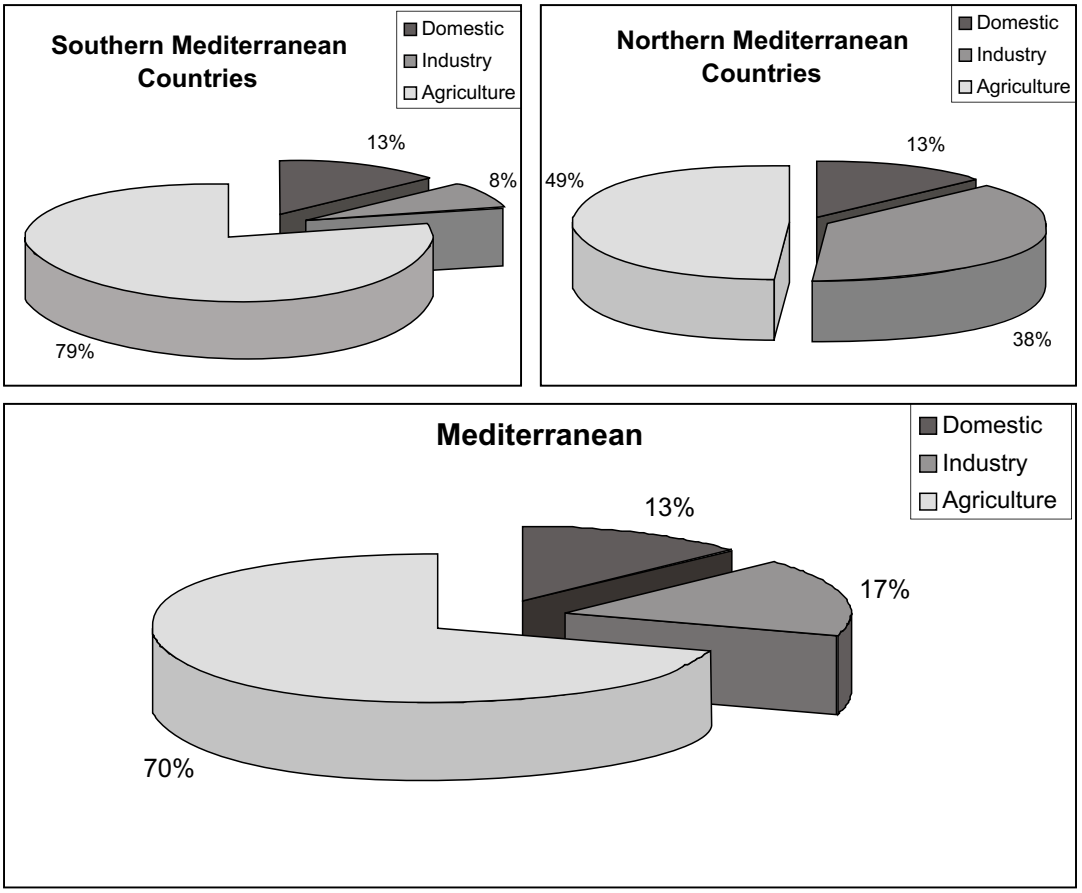


Figure 2. Water use per sector in the Mediterranean

Limiting water resources in the East and South of the Mediterranean basin appears as one of the main factors limiting agricultural development, particularly in the 2000 - 2025 period. The water needed for irrigation is even scarcer than the land itself and the land suitable for irrigation is becoming difficult to find.

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 stabilise 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 urban use. It is likely that the use and recycling of both urban and irrigation wastewater will become necessary in a number of countries, particularly those of the arid region of the Mediterranean area.

Irrigation is extremely water intensive. It takes about 1,000 tons of water to grow one ton of grain and 2,000 tons to grow one ton of rice. In the Mediterranean area irrigation represents 72% of the total water withdrawals.

Despite the high priority and massive financial resources invested in the water resources development, the performance of large public irrigation systems has fallen short of expectations in developing and developed countries of the Mediterranean area. Crop yield and efficiency in water use are typically less than originally projected and less than reasonably achieved.

In addition, the mismanaged irrigation project schemes lead to the "sterilisation" of some of the best and most productive soils. Salinity now seriously affects productivity in the majority of the southern Mediterranean countries as well as in the coastal zone. Salt affected soils in the region amount to nearly 15% of the irrigated lands (Hamdy and Lacirignola, 1997).

Average losses in irrigation projects (Figure 3) suggest that only about 45% of water diverted or extracted for irrigation actually reaches the crops. But losses vary widely; those in the conveyance system taking the water to the irrigation site may vary between 5 and 50 percent.

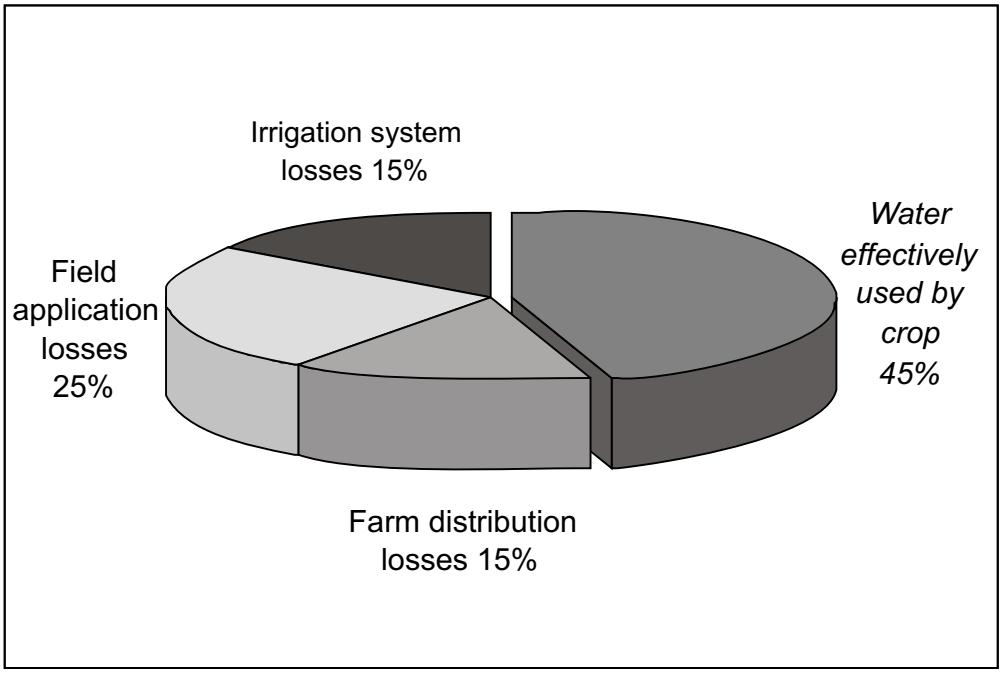


Figure 3. Average losses of irrigation water

Given the increased costs of new irrigation development in the region, together 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.

In the arid and semi-arid region of the Mediterranean a more efficient use of water resources in all sub-sectors activities, but particularly in the irrigation sub-sector, is of paramount importance to sustainable management of the resource base.

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-shortage and dwindling financial resources. Despite these 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, farmers' profitability and environmental sustainability (Hamdy and Lacirignola, 1999).

Individual constraints inhibiting the sustainable development of irrigated agriculture in the Mediterranean countries

There are many constraints, which are inhibiting the sustainable development of irrigated agriculture in both developed and developing countries of the Mediterranean. The importance of individual constraints could vary from one country to another. Often the constraints are closely interrelated; one contributes to the other and vice-versa. Among the main constraints, the following are highlighted:

- lack of funds and substantial delays in their allocation for essential requirements such as operation and maintenance of irrigation and drainage projects, land reclamation, deterioration in data collection activities, etc;
- lack of professional and technical manpower and training facilities and equipment;
- lack of knowledge and absence of appropriate research to develop new technologies and approaches and absence of incentives to adopt them;
- general institutional weakness and lack of co-ordination between various ministries such as irrigation, agriculture, environment, planning, etc;
- lack of appropriate and consistent policies for land and water development in both large and small scale projects; and
- resources: the land and water on which agriculture depends.

These problems include, among myriads of other difficulties: increasing concentration of atmospheric CO_2 level and the related global warming trend; major problems of soil erosion, contamination and pollution of water supplies and salinisation and water logging of irrigated areas (Hamdy *et al*., 2001).

Sustainability and irrigation development

The first questions that may be asked are: to what extent is irrigation sustainable and under which conditions?

Irrigation has been under heavy attack by many environmentalists on the basis that it transforms a part of the territory and produces changes that in the long run may not prove sustainable. While there is little doubt that irrigation development involves profound changes in the physical and sociological environment, these changes have proved to be sustainable overtime.

Indeed, irrigation, when properly managed, is a highly sustainable undertaking if certain basic conditions are met. If the reasons and causes of failures of irrigation are analysed, common denominators can be found in all of them, which can be summarised as follows:

- *Diminishing water resources*: the competition for water is becoming particularly intense in arid environments and particularly due to demands from non-irrigaton needs

(domestic and industrial) found to be a more profitable undertaking than producing crops under irrigation.

- *Weak financial viability:* in an irrigation system where O&M expenditures do not match the fees recovered from farmers, governments in most cases, pays the balance. With a nearly universal outcry for reductions in public expenditures, prospects for survival of many of those systems are grim.
- *Decreasing productive areas.* Two main factors contribute to this undesirable situation: the excessive applications of water by farmers and the water losses from unlined canals. It should be stressed that this is a reversible process; installation of a suitable drainage system can fully overcome waterlogging problems but also a more rational water distribution and more efficient water use may reduce the magnitude of this problem.
- *Reduced land productivity*: several factors can decrease the productivity of irrigated land. They include soil salinisation, soil erosion as a result of poorly designed or managed methods of irrigation, and the leaching of nutrients due to excess irrigation water application. To recover or improve productivity, expensive investments in land levelling, in fertilisation and other agricultural practices are required.
- *Land fragmentation*: many of the irrigation systems, particularly in developed countries, are located in heavily populated areas where farm sizes are very small. Population growth associated with an inheritance system, where land is divided among heirs, has led in many cases to uneconomic farm sizes sufficient to produce food for the family. Subsistence irrigation farming does not generate economic welfare and can make irrigation systems financially weak and unsustainable in the long run.
- *Low prices for agricultural products*: many irrigation systems were planned and constructed on the assumption of higher value agricultural crops, profitable markets and competitive prices. Presently, due to the prevailing low prices for most agricultural commodities, the restructuring of these systems to accommodate more flexible cropping systems is often problematic.

Those parameters beside others are extensively impeding the sustainability of irrigated agriculture.

Irrigated agriculture and future food prospects

In the arid and semi-arid countries of the Mediterranean, the recent trend of overall growth in agriculture production has fallen short of meeting population food needs. What are the prospects for the future? Current trends in food production do not offer a great promise. In fact, many of the developing countries of the region have fallen short in their efforts to meet the growing needs for agricultural products. The trends characterising the future food prospects are not encouraging and suggest that the problem could become much worse. Evidence on three fronts supports this contention:

- population growth at a relatively high rate around 3% accompanied with very fast urbanisation;
- limited arable land and the growing difficulty in expanding areas of productive arable land well suited for cultivation. In the majority of countries, productive arable lands are already under cultivation and what is remaining is the less productive or desert ones to

expand agricultural production horizontally, but, at relatively considerable cost;

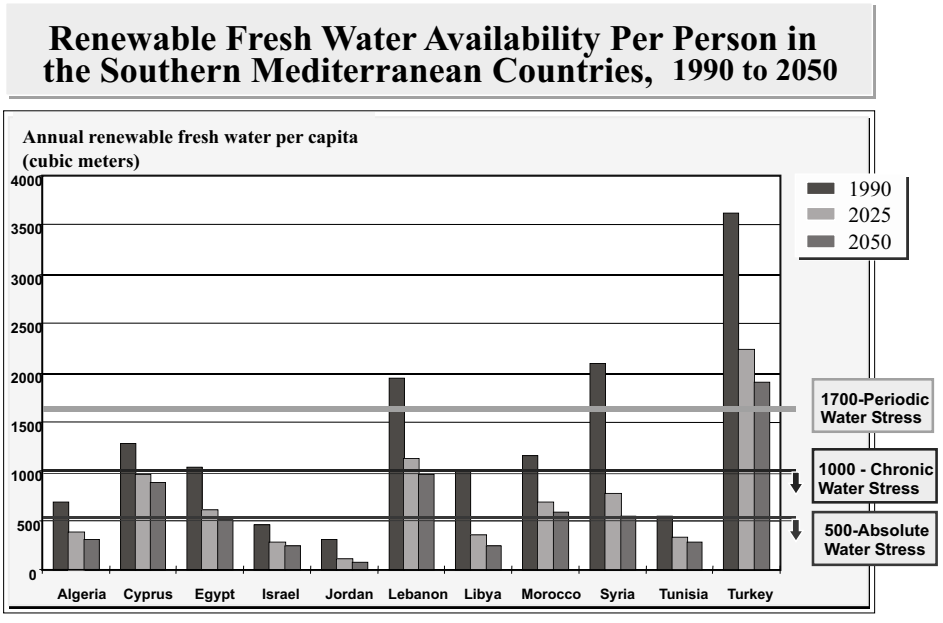
- environmental and natural resources degradation due to our current misuse of those resources: the land and water on which agriculture depends.

Emerging water shortages

Scarcity of water is a major constraint of arid and semi-arid countries of the Mediterranean. In many countries, all available water resources have already been developed or are in the process of development. Water scarcity, exacerbated by water quality deterioration and the lack of effective water management, has become a major problem in several arid countries, and even in humid ones.

At present and in the approaching years, the water demand will fast approach the limit of resources and the majority of the developing countries of the Mediterranean could enter a period of chronic water shortage facing similar problems, at the top of which we will find (Hamdy *et al*., 1995):

Declining water resources per inhabitant, both in terms of water availability and water withdrawals. It is expected that the available water/capita will be reduced by nearly 50% (Figure 4). This will impose its significant effect on the water sectorial use, creating notable competition and conflict among users in the various sectors and of the irrigation and domestic sector in particular; exploitation of water at relatively high rate with the risk of water quality deterioration.



Source: United Nations Population Division, 1994

Figure. 4**.** Renewable fresh water availability per person in the Southern Mediterranean countries, 1990 to 2050

Equally, the crisis of quantity is interacting with another of no less concern: the deterioration of environment, which will not only have a direct impact on water quality, but

also modify rainfall and runoff patterns; such changes will drastically affect the amount of available water in the region.

This evidently emphasises that the availability of water should be regarded in close relation with environmental changes and pollution. Without viewing environmental conservation as a key aspect for assessing availability of water, any analysis of efficient water use is impossible.

Water shortage in the region has been traditionally addressed by increasing supply of water. Expanding the supply, in real terms, is unlikely to effect dramatic changes in the future. Therefore, an essential part of any resource programme for the region must focus on managing irrigation water demand. To satisfy the increasing demands of the other water user sectors, water saving must come from agriculture, knowing that more than 80% of the available water is allocated to irrigation and that water effectively used by crops amounts to 45% and losses could reach even more than 50%!

This is the reason why the problem of water management in agriculture is gaining increased importance in the arid and semi-arid regions of the Mediterranean.

Water quality degradation and water pollution

In nearly all the developing countries, including the Mediterranean ones, water quality programmes are either in their infancy or even non existent. A reasonable clear and detailed picture of environmental issues confronting the land and water sectors does not exist, nor any accurate estimates on the cost of land and water degradation to the national economy.

The cost is already significant at present, and if no drastic actions are taken, the existing trends show that it is likely to become even higher during the 2000s. In addition, the status of water pollution and the extent to which water quality has been impaired for different potential uses simply are not available. On the basis of anecdotal and very limited information available, it can be said that the problem is already very serious near urban centres, especially for groundwater and lakes and for some rivers as well. It should be noticed that, once the groundwater is contaminated, it couldn't be easily decontaminated.

Water pollution is already a serious problem in the majority of the developing countries: a large percentage of wastewater is untreated, and this is directly discharged in the water courses, irrigation canals and drainage ditches.

At our present state of knowledge, we simply do not know the extent of contamination that has already occurred and which may render some water sources unusable in the future without expensive treatment. Protection of water resources, if not receiving a priority consideration, will be a major cause for water scarcity in the region and thereby constraining the agriculture sustainability.

Strategic policies

In the context of the developing countries of the region, the major challenge is to achieve and maintain a sustainable agriculture, as agriculture is still the dominant sector of economy. This is the fundamental base on which the sustainable development is primarily dependent.

In the previous parts of the paper, we tried to highlight some major constraints common to the majority of Mediterranean countries and how they could greatly influence the agricultural sustainability.

The National Research Council (NRC, 1991), analysing definitions of sustainable agriculture, states that "virtually all of which incorporate the following characteristics: long-term maintenance of natural resources and agricultural development, minimal adverse environmental impacts, adequate return to farmers, optimal crop production with minimised chemical inputs, satisfaction of human needs for food and income, and provision for the social needs of farm families and communities".

Speaking about natural resources, the definition is more precise: "the essence of sustainable development is that natural resources must be used in ways that will not limit their availability to future generations".

Current policies and the need for a new approach

Current policies for natural resources management led to a multitude of problems and arid regions today face more difficult problems than ever before. We are in need for a new approach to natural resources management which allows us to overcome the failures of the past, reduce poverty and conserve the environment, all within a sustainable framework.

The new approach:

- addresses quantity and quality of the natural resources (land and water) through an integrated approach;
- integrally links land use management with sustainable water management;
- re-establishes new socio-ecologic balance that should not be pursued in isolation but in connection with the quest for security in food and energy;
- implements greater integration of agriculture and forestry, improves range land management and promotes agro-forestry;
- supports innovation and participatory approaches;
- recognises the importance of tree and forest cover for agricultural productivity and translates into a meaningful administrative, legislative and institutional framework capable of promoting and transferring this approach to the farmers;
- fosters active people participation, through various means with a government management structure functioning well enough to implement the new approach;
- focuses on actions that improve the lives of people and the quality of the environment.

Management of natural resources: challenges

Management of natural resources has to be practised in a manner capable of responding to the above-said aspects: it has to be based on the knowledge of processes which can lead to resource degradation or to the maintenance of natural resources.

Allocation to uses has to consider not only production objectives and environmental impacts, but also the technologies which control resource degradation and enhance productivity; non-productive uses of the land and water should be given a value, as well as the environmentally friendly and improved uses of land and water which help the degradation process to be reversed.

Institutional solutions for land and water management have to combine the capabilities for enforcing policies and rules with the social acceptability of decisions and measures; the objectives for management should not be the natural resources by themselves or the economics of returns, but also the human needs and aspirations.

Strategies

Land and water issues need to be treated in a system's manner and a comprehensive management approach should be developed for the water resources to be linked with the land use policies and management. In addition, physical and institutional infrastructures must be complementary.

Strategic Action Programs (SAP)

Lessons learned and experience indicate that the co-operative preparation and adoption of a Strategic Action Program (SAP) is a critical measure for implementation of priority actions at regional or national level. The objectives of SAP are to: evaluate trends; assess their causes and implications; identify priority actions - both preventive and curative -to address key issues; provide a cost estimate for investments; and establish a framework for monitoring and evaluation.

The SAP should give priority to actions to protect human health, control irreversible physical and ecological damage, and minimise economic losses. An element of this process is the establishment of realistic goals, which can be implemented in a cost-effective manner. SAP should include provisions for participation of regional experts, potentially affected parties and non-governmental organisations in their preparation.

These outlined principles have to be translated into actions through the formulation of regional programmes including: adoption of a comprehensive approach that views land, water use and management and environment in an integrated manner; promotion of regional co-operation to ensure that the concerns of all parties are factored into decisions, recognition of the important linkages between different land uses and variable water resources (quantities and qualities); encouragement of broad-based participation, including local governments, academic and research institutions and non-governmental organisations; and endorsement of a phased programme of action at the regional, national and local level.

This regional approach brings out clear benefits in environmental and economic terms, a more sustainable use of land and water resources, higher yields from agriculture, forestry and animal production.

Improving the management of scarce natural resources: concluding remarks and recommendations

The scarcity of water and arable land in the region is a fundamental constraint to its future economic growth. The problem requires reorienting development away from mining the natural resource base by improving management.

In this regard it is recommended:

The challenging but widely acceptable concept of sustainable development calls for new approaches on development and, therefore, on water and land resources management. New perspectives are required to manage both the soil and water. This is not only a question of allocating and controlling the water and land use, but of combining the knowledge of pressure influencing the resource itself, the relations between users and human and social objectives, the technologies available to improve and enhance the land/water use, the maintenance of biodiversity and the natural environmental equilibrium. Despite the enormous progress on technological and managerial tools which are becoming available to improve management, we still have many gaps in knowledge and mainly, in transferring scientific and technological knowledge into practice.

In the region, the lessons of collective experience demonstrate that we must make a decisive break from past policies to embrace a new approach in water and land resources management that is comprehensive, participatory and environmentally sustainable. The implementation of the new approach is not an easy task and requires difficult decisions; the corner-stone of such an approach is that the national land and water management strategies should emphasise the aspects of institutional and human resources framework, and should address the medium to long-term programmes for building and enhancing institutions and human resource capacities of a country.

There is an urgent need for adequately trained professionals who can work in the multi-sectoral environment of integrated natural resources management. The manager should be knowledgeable about economics, ecology and legal and social analysis in a more complex context. Both success and failure have come from all types of institutions, but high-quality human resources staffing and sound institutions are the best assurance of a country's capacity to achieve sustainable development objectives.

This requires the promotion of issues to enhance stakeholders and farmer's participation in the management of irrigated land and forestry through:

- the improvement of programmes aiming at the transfer of responsibility from government to users relative to the operation, maintenance and management of irrigated lands;
- guidelines for users organisations to administer water and land for different uses;
- the recognition of indigenous knowledge, human reluctance to change and traditional social and environmental arrangements;

- mechanisms which can improve the co-ordination and division of responsibility between government and land users;
- enhancement of the financial institutions and other infrastructures which provide support services in the field of irrigated agriculture and forestry;

The promotion of more sustainable development will not come free of cost. Some countries in the region suffer from the lack of funds necessary to realise agricultural development programmes and projects, which, if not seriously considered, would otherwise negatively influence the agricultural sustainability, which in turn will be reflected on the socio-economic development.

Major emphasis should therefore be given to developing new sources of funds to supplement the traditional heavy emphasis on national budgetary allocations. Particularly important among these approaches, are the measures that seek to mobilise local funds. In practice, this will require building the necessary institutional capacity and generating support and participation by stakeholders in assuming financial responsibility.

However, given the acute economic difficulties faced in many countries of the region, this will in turn require continued heavy dependence of foreign sources of assistance. The contribution of the donor agencies to agricultural development and its sustainability efforts, and its role in mobilising foreign assistance from other sources, will be a significant factor in this equation;

A new policy of reliance on markets and price signals can be expected to help redirect resources to high-value uses, encourage conservation, and reduce the scale of extra investment needed simply to maintain current levels of per capita resource availability. Continuing and reinforcing these reforms, though a difficult task, is vital and urgent;

Finally, to achieve sustainable development objectives and goals, policies and regulations should be grounded in local realities, traditions and natural resource management strategies. The social impact of policies should be assessed before they are implemented. Based on such assessments, targeted measures that minimise adverse effects without off-setting the reform objectives can then be designed and implemented.

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