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in

Hamdy A. (ed.), Monti R. (ed.).
Food security under water scarcity in the Middle East: Problems and solutions

Bari : CIHEAM
Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 65

2005
pages 15-28

WATER SCARCITY MANAGEMENT TOWARDS FOOD SECURITY IN THE MIDDLE-EAST REGION

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SUMMARY – Water in the Middle-East region is inherently scarce as a result of naturally arid climatic conditions. Population increase and economic growth have spurred higher demands for the limited and fragile resources. The underlying historical perception of people, in most countries of the region, that water is a free natural resource supports the dominating influence of traditional, political and social factors in the management and use of the resource. The increasing use of the limited resource in response to the increasing demands is not only reducing its availability but also jeopardizing its quality. In view of the vital importance of water for sustaining life and promoting development, appropriate policies are needed to deal with the problems of water scarcity and the challenges ahead. In the Middle-East region we certainly need continuing innovation and rationalization in our handling of water, but foremost and above all we need to develop and put into action, in countries of the region, a balanced system for the management of the resources. We must work toward a framework for management functions that will integrate consideration of the present and future, of economics and environmental preservation, of technology and building the capacities and of growth and food and water security and sustainability.

Keywords: water resources management, food security, Middle-East region

1. INTRODUCTION

Globally, there is a water crisis. This was the conclusion of the exercise that encompassed the World Water Vision (Cosgrove & Rijsberman, 2000), Framework for Action (World Water Council, 2003), and the second World Water Forum, The Hague, Holland, 2000. While today's crisis is the lack of access of clean drinking water, sanitation and hygiene education that leads directly to millions of deaths of small children every year. Tomorrow's crisis may well be the scarcity of water for producing food, rural livelihoods and sustaining eco-systems.

Indeed, the World Water Vision brought together the new thoughts, plans and strategies of some fifteen thousand odd to find out the sustainable solutions to the worsening water crisis, but, it did not succeed in evolving a widely shared agenda for the way water should be managed for agriculture and rural development. To manage water properly in a sustainable manner is one of the most crucial water issues in the coming decades – and has enormous potential for conflict. This is a major challenge not only for people living in arid regions, but also, for the rest of the world, now, is starting to look at water from a similar perspective.

The question to be asked here is: *why focusing should be given to water and agriculture?* The answer to this question is not because the lion share of available water is allocated to agriculture, nearly 60 % on the globe and more than 80% in most developing countries, but due to the fact that within the agriculture sector there is a high potentiality of water saving and reducing water losses as on farm water use efficiency is very poor being with an average not exceeding the 45 percent (FAO, 2002).

In most arid and semi-arid countries, particularly those of the Middle East, the final goal is to achieve both water and food security. However, most countries are still far away and in need to further effective efforts and hard work to cross the road and overcome the obstacles to change what is desired to reality. This is not an easy process, but a very complex one, but, the key element towards sustainable solutions is fundamentally lying in the way we are using and managing our water resources in the agricultural sector. We have to stop the fragmented approach we are still using in managing our water resources towards an integrated participatory one with major focusing on the demand side rather than on the supply one (Hamdy and Lacirignola, 1999).

This issue as well as other related issues will be discussed in this paper with major emphasis on the approaches and actions to be taken towards achieving water and food security in the Middle East countries.

2. WATER IN THE HEART OF THE MIDDLE EAST

Water has been the key natural-resource during the three millennia of record history in the Middle East. Some regions of the world are drier, and others have higher populations or larger economics, but no other region of the world embraces such a large area, with so many people striving so hard for economic growth on the basis of little water.

In the Middle East region, water is one of the most valuable and vulnerable natural resources (Table 1). Water shortage and the increased demand associated to uncontrolled development, intensive agriculture, mass tourism, overpopulation and over-consumption result in a complexity of interrelated problems affecting social, economic and natural aspects of everyday life.

Table 1. Classification of the countries in the region in respect to the available water resources

Country	Available water resources
Iraq, Lebanon, Syria, Turkey, Sudan and Iran	Fairly well-endowed with water
Morocco, Algeria, Tunisia, Israel and Egypt	Middle endowed with water
Jordan, Libya, Arabian Peninsula countries and occupied territories of Palestine	Least well-endowed with water

Indeed water quality is rapidly deteriorating and many countries in the region have difficulties in protecting their surface and groundwater resources due to weak regulation and poor control on the discharges of untreated domestic and industrial wastewater threatening the ecosystem and human health. In most countries of the region and particularly the arid ones, although problems around the resource availability are normally prominent, the issue of quality of water is gaining recognition, and is already a major problem in the region.

Furthermore, the greater fluctuation in resource availability associated with presumed climatic changes is causing concern as many countries in the region experience increasingly severe flooding and droughts.

From a deep analysis of water resources and its availability throughout the region we can come to the conclusion that the origin of water stress is not limited to the scarcity of the resource, but stems from three interacting crises:

- demand for freshwater in the region exceeds the naturally occurring, renewable supply;
- much of the region's limited water is being polluted from growing volumes of human industrial and agricultural wastes and, thereby, bringing the water quality deterioration to be a new problem dominating the water crisis;
- the same water is desired simultaneously by different sectors in some societies or wherever it flows across or under an international border.

These three crises are interdependent and should not be considered separately, and, therefore, any resolution must deal with all three: quantity, quality and equity at the same time to achieve an

appropriate solution that is economically efficient, ecologically sustainable, and politically acceptable. In addition to the three aforementioned interconnecting crises, other several issues are behind the emerging water crisis as described here below.

2.1. Precipitation variation and uncertainty

The region between the Nile and Tigris-Euphrates is highly varied in geography and climate. Coastal plains merge in a few kilometres with mountain ranges, which then plummet to rift valleys with the lowest land elevations on Earth. Rainfall ranges from more than 1000 mm/year to essentially nil. The average is about 250 mm, which is the limit for rainfed agriculture, but in this region, average can be highly misleading. It is much more important to understand the spatial, seasonal and annual variations in rainfall than national or annual averages.

Rainfall along the cost, at the higher elevation of many countries and in the northern part of the region is more than 500 mm/year, which suggests that irrigation is unnecessary. However, all the rainfalls are in four winter months, so storage systems are necessary to hold back the flow and permit release during the summer when demand of water is at its peak.

The most important variations in rainfall are neither seasonal nor geographic but annual (Biswas, 1994). Considering the reliable flow in the region defined as what can be expected nine years out of ten it is found to be less than 10% compared with 60% up to 80% of the long term average in the Eastern-North America. These year to year variations in the rainfall in the Middle East have enormous implications for water systems. In contrast to Europe and much of the United States, extreme years in the Middle East must be treated as normal, not abnormal, and water planning and management must focus on risk minimization, not maximum use.

2.2. Demography and economy

Most countries of the region are experiencing rapid population growth with rates of 2.5% per year. Although population densities are not particularly high by world standards, density per hectare of agricultural land is another story. Arable land per person in developing countries including those of the Middle East has shrunk from 0.32 hectares in 1961/1963 to 0.21 hectares in 1997/1999 and is expected to drop to 0.16 hectares by 2030 (WSSD, 2002). Other sources of stress come from rapid urbanization which increases the demand for high-quality water, without diminishing the demand for irrigation water and the booming economic growth.

The demographic increase in population at a relatively high rate, the very fast urbanization beside the industrial and economic development, all resulted that most of the countries of the region are consuming much more water than their annual renewable water supply as are Israel, Jordan and Libya. Egypt, Syria and Sudan are fast approaching this situation. Indeed, some projections suggest that by the year 2025, domestic uses (about 100 l/day), plus municipal and industrial uses will require all the freshwater available, leaving non for agriculture.

In those countries with only few hundreds of m^3 per person annually (the case of Jordan, Saudi Arabia, Yemen, Libya, etc.), even if no water is devoted to agriculture over the next few years, these countries will be in trouble in providing the variable sectors with their actual and increasingly water demand and above-all, in satisfying the food demands. For those countries, apart from desalination or imports, the only ways to significantly improve the situation are to increase water efficiency in existing uses and to shift water from low productivity to high productivity water sectors. The dominance of irrigation means that both efficiency improvements and sectoral shifts must emphasize agriculture.

In the future years, the population growth will be one of the principal causes for the worsening already serious situation of the water availability in the region. The composite effects of climate, poor supply, maldistribution and escalating population are revealed in exponential discrepancies of water supply per person across the region, ranging from a per capita supply of 115 m^3 in Libya to as much as 2000 m^3 in Iraq. A disturbing related trend has emerged in recent decades: over the last 30 years, the average available supply of water for the entire Middle East has fallen rapidly from somewhat more than 2000 m^3 per capita to less than 1500 m^3 per capita. Presently, more than half of all Middle

Eastern countries are confronting serious water decline in water withdrawal/capita amounting to only several hundreds cubic meters (Fig. 1).

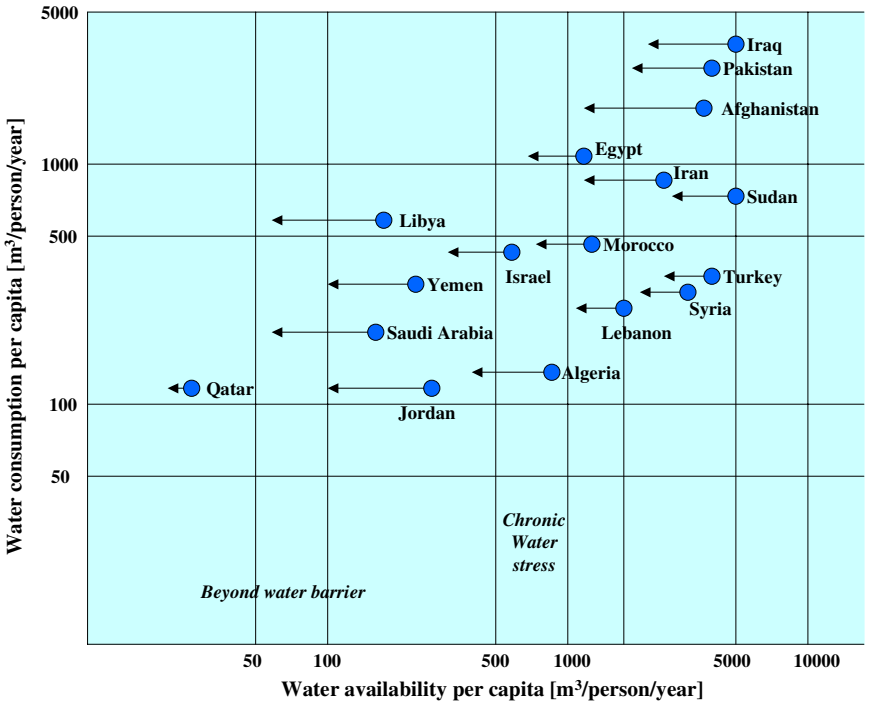

Figure 1. General characteristics of water availability and water consumption [m^3/person/year] in the Middle-East countries for the period 1990-2020

2.3. Limited of information on water resources

Data availability and reliability are important considerations for the national water master plans. Adequate data are generally not available for efficient water planning in most countries of the region and the reliability of some of the data available can often be questioned. Absence of an accessible information system means that even some of the data that were collected in the past are not available to the planners. Good planning depends on the availability of reasonable amount of correct data. Thus every planning must give considerable thought to what type of data are necessary, how they will be used and for what purposes.

Furthermore, there is nowhere the information available on water use as detailed or comprehensive as that on water supply. Worse yet with some exceptions, the information is based on deliveries of water not actual use, which means that it is impossible to make accurate measures of efficiency.

A basic problem in the region is inadequate knowledge both of natural and potential water resources and of present and forecasted water demand. The supplies of water resources are controlled by a set of stochastic variables. It is thus essential to know not only their average values but also their spatial and temporal distribution.

Lessons learned and experiences gained from the region indicate clearly that the absence of a developed accessible information system is the main cause of being not capable to govern the water resources, its efficient allocation as well as the mismanagement and the inefficient water use.

In the region efforts must be intensified to gather fundamental water data, organize them into usable and accessible forms, and disseminate them to all who need them. Regional data collection and sharing is an important part of the rational management of any resource. Basic water resources data must be considered, classified or withheld from other nations. Unless, nations share hydrological data, no satisfactory agreements on allocation, responses during shortages, flood management, or long-range planning can be reached.

Data management is a main issue and an essential one for making reliable prediction of supplies to formulate allocation strategies. Modern computerized data processing systems need to be installed, with the training and manpower development programmes that they imply, for water data base development, for water management, and for timely dissemination of information.

An integrated information system is needed to regularly record and disseminate climatic data, including rainfall, and data from hydrological networks and river gauging stations as well as those of groundwater and land use planning. It would be a benefit for the region to establish an institutional framework for conventional remote-sensing data program and the use of geographic information system (GIS) technology to set up the required data base for hydro-meteorology and water use.

2.4. Policy harmonization

Water plans are generally carried out by the Water Ministers. During the planning process, forecasts of water requirements for the different sectors are made, and environmental and social constraints are generally considered. However, each major Ministry, like Agriculture, Industry, Power and Environment has its own sectoral policies, which invariably have direct implications in terms of water requirements and use, and thus, on the water sector planning itself. Generally, these different sectoral policies are not harmonized in terms of water, and without such harmonization, the national planning process leaves something to be desired.

Few attempts have been made in the past to harmonize such policies, but with limited success. The issue of sectoral harmonization thus requires attention. Indeed, a sectoral approach to water development is a major institutional constraint in all countries of the region, and this has an important bearing on the sustainability of projects as well as on water policies, being not effectively expressing the exclusive domain of the water source sector.

At national level, to harmonize the water use and its allocation among the different concerned sectors, it is needed to analyze the links between water and other sectors of economy, including those in agriculture, industry, transport, energy and health to formulate an overall national water policy entailing:

a) policies covering the water sector as a whole;
b) policies relating to specific sub-sectors of water resources, such as potable water and irrigation, and
c) policies concerned with other sectors (e.g., energy) that affect water resources.

2.5. Water use conflicts in the Middle East: trans-boundary rivers

It is well recognized that shared water resources is nowadays the most sensitive or explosive issue in the Middle East Region. In the region there are several important rivers shared by two or more countries: the Rivers Nile, Euphrates, Yarmouk, Litani, Jordan and others. In addition, there are shared underground water aquifers like the Nubian sandstone aquifer and the Arabian Peninsula aquifer. The development and management of these shared water resources pose special challenges which sometimes become explosive political issues.

The intricacies of conflict have been multiplied in the latter half of this century by the rapid degradation of the environment on a global scale, in significant parts as a function of rising demographic trends and the concurrent economic development, resulting in very serious resource scarcities in the region. These circumstances have increased competition for the resource, animated aggressive nationalist sentiments and created many flash points of possible conflicts, subjecting the international system to greater strain than ever before and making the resolution of conflicts exponentially more complex and more difficult to achieve. Such situation is especially peculiar to conflict over water, particularly when two or more national actors contend over the same supply of water in an international basin.

Past and recent experiences indicate that the complex and politically sensitive issues of international river basins cannot be solved unilaterally by individual countries (Biswas, 1994). They would require genuine cooperation between countries as well as understanding and appreciation of

each other's need. Such cooperation could manifest itself in the form of joint action plan, joint commissions or even treaties. What is needed is regional and sub-regional cooperation.

In this regard, the most promising approach would be to encourage cooperation among scientists and technical experts. If scientists and technocrats in the area together with the officials they advise, can communicate sufficiently to develop shared understanding of the water situation of available and new technologies, and of potential solutions, they could constitute a community of informed specialists throughout the region, and become a strong force for cooperation by pressing for and guiding effective water policies.

The regions in this context are not necessarily political regions but rather ecological regions like a lake or river basin. What is now required is not cooperation in dividing amounts of water but genuine cooperation in the implementation of agreed plans for the integrated development of the whole basin for the benefit of the countries in the region. Such cooperation can come only through availability of reliable facts and consideration of all feasible options with an effective participation of leading technocrats of the region and renowned experts on Middle East water from outside the region. In the Middle East region, cooperation should be the superordinate principle to peaceful solutions to shared water resources conflicts and water should serve as a catalyst for such cooperation among the region rip-rains (World Water Council – World Bank, 2003).

3. WATER SECURITY AND FOOD SECURITY INTERACTIONS

The greatest water problem, which made most of the Middle-East countries still far away from achieving food security, is our failure and inability to link environmental security, water security and food security (Fig. 2).

From a deep analysis of this triangle with its three components, we can say that the irrigated agriculture is occupying the centre of this triangle and is directly or indirectly connected to each component included in the triangle. The reason behind this is that water allocated to the agriculture sector represents more than 80% of the available water resources in the region with losses exceeding 50%.

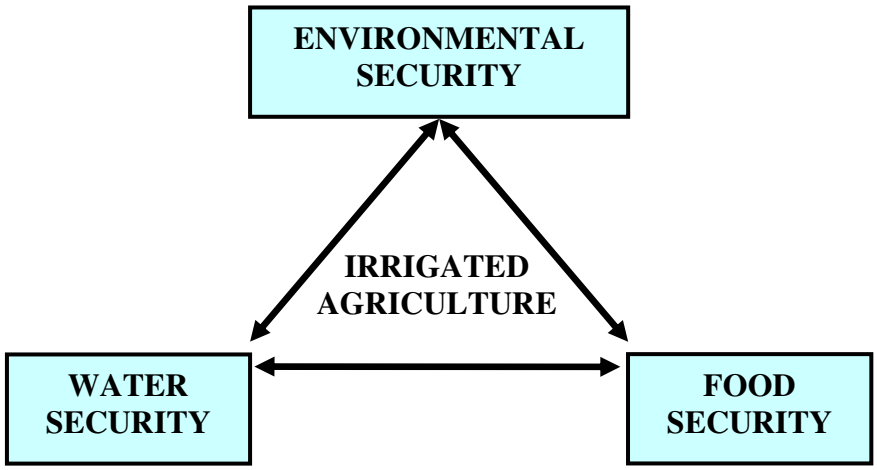

Figure 2. Food security, water security and environmental security relationship

Indeed, the big gap in food production in the region and the immense difficulties most of governments are facing to supply the inhabitants with the necessary food is fundamentally the result of water mismanagement in the irrigation sector. The irrigation sector is characterized by enormous water losses. Improving the irrigation water management to reduce the losses even by 10%, from 50 to 40%, will lead to an ample increase in the available water resource. The more is our capacity in reducing the water losses and increasing water saving in the agricultural sector, the higher will be the probability to achieve water security that will lead the region to food security.

In the most countries of the region, sustainability of food production increasingly depends on sound and efficient use and conservation practices consisting primarily of irrigation development and management. Achieving food security is the top priority in many countries, and agriculture must not only provide food for rising population but also save water for other uses (Hamdy, 2003).

The recent trends of overall growth in agriculture production have 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 behind in efforts to meet the growing needs for agricultural products. The trends characterizing the future food prospects are not encouraging and suggest that the problem could become much worse.

For sustainable use of water resources in irrigated agriculture, to meet the challenge it is now facing and the future difficult ones, is not one way solution but it consists in crucial issues and options putting all together may provide a better understanding of the problems we face and their consequences, possible solutions and the interconnections and tradeoffs among them.

In the region, in order to survive the consequences of water scarcity, approaches have to be undertaken by professionals such as:

- strictly manage the demand for that precious resources, preserve and augment the supply or more preferably to combine the previous two options in an integrated management plane aiming ultimately towards sustainable development;
- effective water saving programmes and strategies in all water uses sectors and, particularly, the agriculture;
- increasing water productivity;
- the re-use and recycling of non-conventional water sources as additional ones.

Our attempt here is to outline key issues that warrant our priority attention as we seek to move from a common understanding of the problems to concrete actions to be implemented.

4. WATER RESOURCES MANAGEMENT: TRADITIONAL VS. NEW APPROACH

4.1. The traditional hard-way approach

Such traditional exercises were fully focusing on supply-side solution relying on ever-larger number of dams, reservoirs, and aqueducts to capture, store and ever-larger fractions of freshwater run-off. Such approach is now beginning to fail for environmental, economic and social reasons. Basic human needs for water still remain unmet. It is becoming harder and harder to find new, or even hold onto existing water resources to supply croplands.

Under such traditional approach, water planning efforts usually did not include a detailed analysis of what 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 ecosystem from which water supplies have been withdrawn. Those could be some of the driving forces beside others including high costs of construction, tight budgets, deep environmental concerns, new technological advances and the changing nature of demand for water for changing the way we are following in planning and managing our water resources.

As increasing water supply is questionable, water resources management should be directed towards the soft-path approach through developing new methods to meet the demands on growing population without requiring major new constructions or new large scale water transfer from one region to another (RMI, 2002).

4.2. The soft-path – a new water management approach

The “soft path” strives to improve the overall productivity of water use rather than seeking endless sources of new supply. It matches water services to the scale of users’ need and work with water

users at local and community levels. And, above all, it takes environmental and social concerns into account to ensure that basic human needs and the needs of ecosystem are both met.

Nowadays, there are growing calls for the costs and benefits of water development to be distributed in a more equitable manner and for unmet basic human needs of all affected stakeholders. New water supply systems have increasingly become expensive and to be fully subsidized by governments seems very difficult because the governmental budgets in the majority of the countries are now under great pressure and there are serious constraints on new money for major water projects. Those are some of the reasons to respond why our efforts and thinking should be directed to change the traditional approach in managing and planning our water resources to a sustainable soft path putting greater emphasis on development principles that reflect environmental, social and cultural values.

Our success or failure in the implementation of the soft-path approach in managing the water resources to meet the human basic needs, in particular food security, is absolutely a matter of whole society able to implement successfully the required management instruments, the establishment of the enabling environment together with an appropriate and updated institutional framework (Fig. 3).

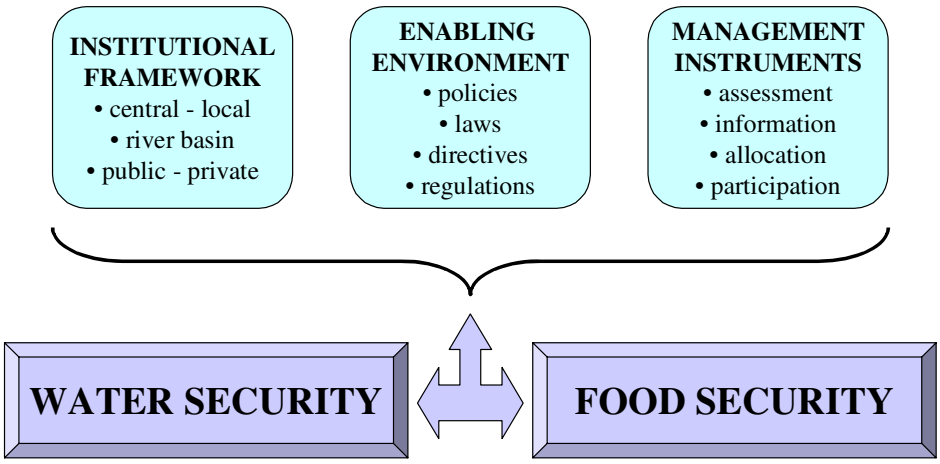

Figure 3. Water and food security basic requirements and tools

In the region, hard and serious work is needed to establish, arrange and organize in the best mode the pre-conditions required for an appropriate integrated demand water management. The developing countries of the region are greatly suffering big shortages in the water-managers who are capable not only to evaluate the problems, but to find the reasonable solutions; those with good understanding the connections between water and ecological health, and the links between the health of natural ecosystem and human well being to integrate ecological and human water needs in a comprehensive way. The capacity building in the water sector in the region is still weak. The human sources are the actual wears moving any expected changes and improvement in the water use and its management.

5. WATER SECURITY AND FOOD SECURITY: THE WAY FORWARD

5.1. Water resources towards development and management

Given the current and future demographic, social, and economic challenges affecting water resources in the region, governments have come to realize that a new approach to water resources management is imperative. Countries of the region now recognize that:

- Effective water governance is a priority challenge. It is the entry visa and bottleneck to tackle the water problems and conflicts effectively and to achieve the sustainability of water use and management, both the keys leading to water and food security;
- Water Sector Issues cannot be any longer addressed in a fragmented manner. The concept of integrated water resource management is now the focus; and

- Water resources policy is to be designed within the border context of a national development strategy. Water resources are to be established as a national asset, whereby policies affecting the allocation and quality of water resources in the region's countries can be seen as positively or negatively impacting economic growth, development and food security.

A review of most of the water sectors of different countries shows that adopting an integrated approach to the management and conservation of the water resources, increasing economic efficiency of irrigation water use, restricting water sector institutions and building capacity are common threads. Those are the major issues characterizing the road ahead to achieve both water and food security. However, passing from generalized issues to the specific ones, the following question emerges: *The priorities: where and how to focus?*

5.2. Effective water governance

Water governance refers to the range of political, socio-economic and administrative systems that are to develop and manage water resources and the delivery of water services at different levels (GWP, 2002).

In the Middle-East region, the importance of governance of water resources for sustainable development is well recognized politically, but within the water community there is little recognition of its centrality.

Water governance should be a priority action to resolve the complex challenges most countries in the region are facing in the water sector. However, the various water reviews in the region give the impression that there is failure rather than success in governing our water resources. The reason to this could be mainly attributed to the absence of the enabling conditions required to govern the water resource effectively. Without an appropriate setting for the conditions needed we shall never be able to satisfactorily govern the water resources in the region. In this regard efforts should focus on:

- Improving regulation; clearer definition of roles and relations; better allocation mechanisms to bring water distribution in line with society's changing needs; capacity building to prepare individuals and institutions and improving financing, including better use of existing budgets.
- Water governance must be seen within border governance systems in society and must account for social changes.
- Several changes should be taken and the process of change should be principally based on:
  - building as much as possible on existing arrangements,
  - capitalizing on opportunities and being realistic,
  - opening processes and policy-making with all stakeholders as far as practical, and
  - establishing effective socio-political and administrative systems adopting an IWRM approach with transparent and participation processes that address ecological and human needs.
- To identify clearly what needs to be done by different players and what should the different players do.

5.3. Water management strategic options

Resource management strategies, in general, are coherent statements indicating how particular resources would be developed, and what is the approach that would have to be taken to achieve one or more management objectives successfully? The principal objective for the water management in the Middle-East region with its sub-regions is to ensure steady supply of water, based on achieving a balance between water supply and demand in all of its areas, and to make future use of water economically feasible in order to realize sustainable development in the sub-region. This implies that a certain number of strategic principles should be followed (Abu-Zeid & Hamdy, 2003):

- the strategic options have to be cross-cutting in nature, therefore capable of securing highly integrated solutions, with the aim of involving a variety of interested socio-economic sectors as well as stakeholders;
- the proposed strategic options have to be, on one hand, comprehensive enough to encapsulate most of the problems in water sector, as well as have a wide geographic coverage; however, the packages of actions in each of the options, on the other hand, have to allow for the possibility of adjustment to local situations and conditions;

- the strategic options have to be based on the assessment of local situations in order to find what are good existing practices and what could work in the future water resources management in the individual countries; improvement of such practices, and replication of successful approaches will make this strategic option implementable.

5.4. Institutional dimensions

The fragmentation of the institutional framework and the complex coordination mechanisms have been pointed out as a characteristic in many Middle-East countries. Different government ministers and agencies deal with many sub-sectors of the water sector, without tight appropriate linkages between them. A major challenge for sustainable water management in the region is the effective functioning of water services and the proper maintenance of water networks in urban and rural areas. The creation of specialized public organizations or delegated management to the private sector with BOT and BOOT systems are seen as important options. These options require, in turn, the reinforcement of the regulatory functions of government organizations and the effective enforcement of regulations. Countries need institutional, educational, and financial support to insure effective operation of institutions.

The institutional objectives have to cover the strengthening of water management and regulation functions, the improvement of information and assessment of water resources systems, the promotion of the participatory management approach and to provide the water sector with needed investments.

6. ANSWERS TO RESOLVING ISSUES OF FOOD SECURITY

In the region, some of the answers to the resolving issues of food security and stability in food production will increasingly come from improved water management and its sustainable use in the agriculture sector. However, to be realistic, we must have fully in hand the approaches and the alternatives, the actions needed and above all, we should know how to proceed and implement approaches and actions on the ground. For achieving food security in the region, the areas of focus are highlighted below as recommended by Abu-Zeid and Hamdy (2003).

6.1. Efficient water saving programmes

In the region, we have the knowledge and tools to increase irrigation efficiency, reduce losses and save more water in the agricultural sector. Each drop of saved water could be used for irrigating new lands and having more food production. However, we have to learn the lessons that putting much stress on only technical aspects for water saving will not yield the results desired; it should be coupled with economic initiatives to reduce the increasing water demand and to use water more wisely in the agricultural sector.

6.2. Improving crop productivity

By improving the productivity of water in rain-fed and irrigated agriculture, we can have more production in food with less need to expand irrigated area. There are several means to increase the productivity of water: higher yields using the same amount of water through improved varieties, improved soil management practices that save water through reduction in non-productive evaporation or flows to sinks in excess of environmental requirements, and reallocation of water from lower to higher value uses (FAO, 2003). In a broad sense, increasing water productivity in agriculture contributes not only to the overall food security equation but also to water security.

6.3. Rain-fed agriculture improvement

Generally, rainfed agriculture is often ignored in the water and food security puzzle. In the Middle-East region, rain-fed agriculture contributes by about 60 percent to cereal production and about 70% of the total cereal area. Consequently, a one-percent increase in rain-fed cereal production would have about one and half time the effect than a similar increase in irrigated cereal productivity. This

clearly illustrates the influential role that the improvement in rain-fed agriculture could have on the overall food security in the region. There is a number of water harvesting techniques, groundwater use, storage and water application practices being developed that have potential to raise the productivity in this area. Many of these practices are practically suitable for use by smallholder farmers and can go a long way in the fight against poverty.

To improve cereal production under rain-fed agriculture areas to focus on are:

- the development of drought resistance crop varieties, frequent tillage practices to conserve water (fallow) and low cost technologies or simple water harvesting structures to provide access to water at the critical growth stages of the growing crops.
- supplementary irrigation with freshwater and even with low quality and saline or treated waste water at the critical growth stages of cereals and, particularly at the flowering and seed filling stages (Hamdy *et al.*, 2003).

6.4. The re-use and recycling of wastewater

Although the quantity of wastewater available for re-use accounts for a small fraction of total water requirements, it represents an attractive option for water scarce countries, since it is a renewable and valuable source of water, which has the additional advantage of being rich in nutrients and organic matter.

In the region, answers to the resolving issues of food security require that emphasis be given to the technical areas previously discussed, but these should also couple with the promotion of the following policy imperatives:

- to increase public participation in the management of irrigation systems and decision-making about water and resources;
- to establish mechanisms for effective cost recovery by paying for water services;
- to establish actually acceptable water rights and allocation mechanisms;
- to establish means of accountability between service providers and users;
- to promote local management of irrigation systems with a strong emphasis on farmers' participation, the establishment of Water User Associations (WUAs) and acceleration of Irrigation Management Transfer (IMT) programmes.

In the Middle-East region, to achieve food security, the only option we have and should be followed is the use, the reuse and recycling of each drop of wastewater. This is the way to provide more opportunity for water to better meet not only the agricultural demand, but human and nature demand as well.

7. CONCLUDING REMARKS AND THE FUTURE CHALLENGES

Water security and food security and their achievement in the Middle-East region are highly interconnected. Any improvement in the water sector will have its beneficial effects in lowering the increasing food gap, enhancing the agricultural and food plans and policies and bringing the region smoothly towards the desired food security. However, to achieve the goals several actions should be taken. The difficulties are not in deciding on the actions but how to implement such actions on the ground. This is the task and there is no way to escape from the responsibilities.

The challenges we are facing are numerous and complex, some are under hard-work and in progress but there is still others seeking further elaboration and intensive efforts to attain both water and food security and sustainability in the region, among those are the followings:

7.1. Improved involvement of water professionals and private-public partnership

Many communities are now reaching socio-politically sensitive limits of water availability, where the cost of managing shortages of water is becoming a constraint on the lives of individuals and on economy. Averting a full scale crisis will require changing attitude at all levels and making the mental shift from asking how much more water is needed in deciding what activities can be best afforded with the water available. That shift in thinking will result in water development being tackled in a coherent

integrated manner, by a combination of strong public and private sector institutions, and with vision that looks beyond the boundaries of individual activities. Both private and public professionals can be appealed to rational management and increased funding required in the water sector

7.2. Promotion of central policy – making and decentralized management

An integrated strategy for managing water as a common resource ensuring its rational use is urgently needed. Traditionally, for most the countries of the region, water sector institutions have overlapping tasks; and competing users, making the coordination of resource planning and management by a central institution critical. Some form of national water body should be responsible for designing and implementing the national water strategy. The mandate of this body, and the sector's organization as a whole, should be described in a water law that defines water as a public good, recognizes water rights and creates autonomous and decentralized managerial units; as well as setting water quality standards, pollution control and conservation guidelines. Water delivery, by contrast, should be decentralized, to be the responsibility of local irrigation authorities, water and sewage utilities, and rural communities.

7.3. Building a partnership approach

In most countries of the region, it is needed to establish practical rules for local partnership among the various stakeholders active in the development and management of the water sector (local authorities, operators, communities and NGOs). Partnership between operators and partners possessing immediate knowledge of local circumstances and able to maintain relationship with members of the community is therefore fundamental. Such partnership must become more flexible and be combined with public-private partnership.

7.4. Promoting gender equity in water decision making

Integrating gender concerns in water decision-making is important not to greater equity but also for greater efficiency. Accelerating poverty alleviation and socio-economic development in the Middle-East countries depends on mobilizing every available skill, thereby, increasing natural resilience and empowering people to improve their own lives. In most countries, the will to change is growing and there are some replicable examples of successful measures for promoting gender equity in decision-making. However, still needed is a better understanding of what has to be done, what can be done and how to do it? Practical methods such as budgeting and gender analysis of programs and projects need further development.

7.5. Managing water and energy benefit both

The challenge is to improve the use of existing infrastructure, reverse the decline in the stock of infrastructure, and design new projects in a way that allows public participation and the selection of optimized solution for society. What should be enforced in most countries of the region is the understanding and cooperation between the professionals in both the water and energy sectors. Energy professionals at all levels, including governmental and non-governmental organizations, must give more thought to water and equally water professionals must give more thought to energy.

7.6. Improving financial performance

Financial issues are related and dependent upon institutional structure. Regional and national financial strategies would need to be developed in line with other government strategies in national development plans, such as in economic development, poverty alleviation, environmental protection and energy production.

In many Middle-East countries, however, there is much to do at the implementation level to ensure financial self-sufficiency of the irrigation, water supply and sanitation sectors since they heavily

depend upon central governments. Generally, the cost of providing water in all sectors is not fully recovered, and this has normally led to a downward spiral deterioration of the provided service. Concrete financial solutions are urgently needed to guarantee adequate and fair access to the service.

7.7. Changing the attitude and behaviour of people towards water

Success in this feature means increasing people's awareness and knowledge. People in the region are becoming more aware of local and national water scarcity. Despite significant advances in this field, governments are still timid in enforcing conservation measures or informing the public why economic incentives are needed to conserve water and shift it to highest–value uses. Appeals at all levels, especially through schools and media – based public education campaigns are, thus, to help radical change in behaviour. In this regard, local–language information packages should be developed for primary and secondary school students and extension programs to promote water values and ethics and to inform people about water's many vital functions, about the causes and impacts of pollution, and about solutions. What is actually needed in the region is water should have the place it deserves during this decade of Education.

7.8. Capacity building for the local institutions and water user groups

In the Middle-East countries, major efforts are carried out to improve the capacity building in the water sector. The continuous changes and the updating of the educational and training programs had resulted in building up a wide base of engineers and specialists of high calibre and the modernization of many institutions covering the different water sector activities.

This was not the case for the new institutions created by decentralization and their newly assigned roles and tasks although effective implementation of water strategies and assigned programs requires improving local authorities and user groups. Thus, in the region, attention has to shift to capacity building of the decentralized agencies in their new institutional context; this is what we have to focus on so that they can work effectively in a participatory, people–and service–oriented approach with water groups, communities and households. This requires that central agencies also have to be transformed, so that they can take up their new roles and responsibilities.

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