Centre for Environment and Development for
the Arab Region and Europe (CEDARE)
2, El Hegaz Street , Heliopolis , Cairo , Egypt
Tel: +20 2 4513921/2/3/4 Ext: 661 - Fax: +20 2 4513918
Email: water@cedare.org - Website: www.cedare.org

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CENTRE FOR ENVIRONMENT
AND DEVELOPMENT FOR
THE ARAB REGION AND EUROPE

WATER CONFLICTS

and Conflict Management Mechanisms in the Middle East and North Africa Region

2006

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Executive Summary

Water is essential for supporting life, meeting basic needs, safeguarding public health, protecting the environment, and supporting agriculture, industry as well as other human activities. MENA is the driest and most water scarce region in the world and this is increasingly affecting the economic and social development of most countries of the region. MENA has about 0.7% of available world's freshwater resources and in the mean while is the home for 5% of the world population. The rapid population growth in the region and the increasing demands for water are all putting unprecedented pressure on the resource. As a result; competition, disputes and conflicts over water are inevitable in the region.

Various challenges face water resources management in MENA and they have also been identified as the main sources of conflicts over water. The most fundamental source of conflict is **water scarcity** in terms of quantity and quality. Many countries in MENA are currently using their water resources in an unsustainable manner, which will lead to more problems and conflicts in the near future. The problem is driven by **high demands** for water due to the rapid population growth rates and higher living standards in the urban areas. The water scarcity problem in MENA is also accentuated by the **high seasonal and spatial variability** of the water resources due to climate change and consecutive droughts. On the other hand, the **water use efficiency is low** for almost all water-user sectors, especially irrigated agriculture. The industrial sector is known for generating highly-polluted wastewater that is not properly treated prohibiting its reuse. The **water policies** are sometimes **not carefully formulated** and hence give wrong indications to the water users to invest in developments that cannot be sustained by available water resources or encourage them to adopt unsustainable practices. The **lack of public funds** necessary to operate and maintain the large water services and irrigation projects coupled with the **low water tariffs and collection rates** run those services down and jeopardise their capital investments. The **institutional setup** in the water sector is characterised by **inadequacy and lack of harmony**, which is related to the multiplicity of water authorities and hence their overlapping and conflicting functions. The **participation of the water users** in the management and operation of the water resources is still inadequate, which is perhaps related to the **improper governance and centralization of decision making**.

Competition over water can be between neighbouring countries, between sectors or between different groups or users in the same sector. Similarly, water conflicts can involve different parties: public-public, public-private and private-private; with the public party being governments and their agencies and the private party being the water user sectors, groups or individuals.

The type and severity of water conflicts may vary depending on the region where the conflicts take place. In non-arid regions, water disputes and conflicts are usually related to development activities resulting in environmental concerns such as dam construction or transboundary pollution. On the other hand, in arid and semi-arid regions such as most of MENA, water disputes and conflicts are chiefly related to the problem of water scarcity, although they may also involve similar issues related to development activities.

Perhaps the oldest and most frequent type of competition over water is that between upstream and downstream users sharing the same source of water. Typically, the upstream users are always accused of over-using the water or taking more than their fair share. On the contrary, the competition between surface and ground water is interchangeable: development of catchment areas for rainfall harvesting, rainfed agriculture or diversion of run off flows can reduce the rate of groundwater recharge for downstream users and hence deplete the resource. On the other hand, over-use of groundwater can deplete springs. In addition, there is also the competition between groundwater users by for example having two wells too close to each other such that they interfere with each other. Finally, competition over water between the various water-user sectors is also on the increase. The domestic and industrial sectors are the most competing sectors with the agricultural sector trying to claim more of its large water share.

Various conflict management and resolution mechanisms evolved or have been introduced in order to deal with water conflicts in the MENA region. They can be broadly categorised as social, institutional, legal and financial mechanisms. Each type of these mechanisms has its enabling environment that is a prerequisite for it to achieve its purpose. Accordingly, some of them have been more successful than the rest. The following matrix outlines those different conflict resolution mechanisms and their enabling environments.

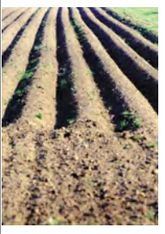




Conflict Resolution Mechanism	Enabling Environment	Performance
Social mechanisms:		
• Community/tribe leaders and influential people	• Old communities with strong social structures and ties (kinship, tribal, etc.)	• Has been very successful in resolving conflicts in communities with historical civilisations such as in Egypt, Iran and Yemen.
Institutional mechanisms:		
• Water user organisations	• Water users are welling to cooperate together. • Proper and active legislative support. • Adequate training and capacity building to water users, especially in the early stages of organisation establishment.	• Varying performance depending on the age and maturity of the organisations and the existence of the enabling environment. For instance, different types of organisations are emerging now in Egypt and hence many of them have not been very effective yet. In Morocco, most of those organisations are relatively old and effective.
• Special institutions or committees	• Clear mandates for those institutions. • Their decisions should be binding.	• Usually deal with conflicts between institutions, not those involving individuals. • If they fail, the disputes may be referred to the judicial system.
Legal mechanisms:		
• Customary rules	• Old communities with social mechanisms for conflict resolution.	• Has been very successful in resolving conflicts.
• Law	• Clear legislations in order to prevent misinterpretations. • Regularly reviewed and amended as may be required in order to respond to new challenges.	• Not highly efficient because the water legislation in some countries are old and are therefore largely incompetent to meet the challenges of today's disputes and conflicts.

Conflict Resolution Mechanism	Enabling Environment	Performance
	• Strong law enforcement. • Fast judicial system.	• Individuals are reluctant to resort to the judicial system in fear of endangering community ties, the long and bureaucratic procedures and the weak law enforcement.
Financial mechanisms:		
• Water tariffs/service charges	• Water metering. • Must consider the ability of all users to pay (e.g. scaled tariffs). • Important to make people aware that they are paying for the service not for the water itself.	• Works well with piped water delivery networks (groundwater for irrigation and domestic water supply) because of ease of metering. • Usually causes some conflicts between governments and users when tariffs are increased.
• Water markets	• Water users must have acknowledged water shares. • Water is not associated with land.	• Caused more conflicts than helped resolve them. • Conflicts between shareholders fighting to sell their shares. • Conflicts between governments and shareholders against selling of water for non-irrigation purposes. • No need for separate water markets when land and water are associated together since there are land markets.

The current conflict resolution mechanisms can be reinforced by: 1) making the formal water user organisations more effective in such a task, 2) adopting participatory approaches in water resources planning, management and utilisation, 3) continuously revising and updating the water legislation in order to keep pace with the dynamic nature and continuous challenges of the water sector, 4) simplifying the procedures for dealing with water conflicts and disputes through the judicial system, 5) levying water-service charges that are based on actual consumption not on flat rates and using a tariffing system that takes the ability of the users to pay into consideration, and 6) training and capacity building of government staff as well as launching public awareness campaigns in order to enlighten the people about the challenges facing the water sector.



1.Introduction

Water is essential for supporting life, meeting basic needs, safeguarding public health, protecting the environment, and supporting agriculture, industry as well as other human activities. About two-thirds of the Earth's surface is covered with water, but only 3 percent of the world's water is fresh (World Bank, 1994). Yet, only 13% of the global fresh water is accessible and the majority of which is groundwater. This quantity of water has been constant over the whole life of the Earth while in the mean time the number of people living on the planet has been swiftly increasing. Demand for water supply is rising rapidly, challenging its availability for food production and putting global food security at risk. As a consequence, water is becoming an increasingly scarce resource in many parts of the world. Nonetheless, many countries are still using up considerable amounts of this scarce resource in supporting inefficient public sector institutions for both irrigation and water supply.

Water availability – or scarcity – is not evenly distributed all over the globe. According to WRI (2005) the average renewable water resources per capita are 47044, 19992, 10665, 4079 and 1505 m^3/year for South America, North America, Europe, Asia and the Middle East and North Africa (MENA) regions respectively. Similarly, water availability is highly variable within each region. For example, within MENA the per capita water share is currently less than 200 m^3/year in Yemen and Jordan.

Scarcity eventually assumes competition over the resource. Competition over water can be between neighbouring countries, between sectors or between different groups or users in the same sector. In addition, because water is such a vital resource, fierce competition can be foreseen to lead to disputes, conflicts and maybe fights.

This study investigates water conflicts at the sub-national level in the MENA region through five country case studies; namely Egypt, Iran, Jordan, Morocco and Yemen (in addition to a special case study from Djibouti). The countries selected as case studies represent the different environmental, water availability, socio-economic and institutional characteristics that are present within the region. The study looks at the working rules and mechanisms for minimising or resolving conflicts over water allocation and use. It also investigates the resilience of the traditional mechanisms to change in response to the increasingly water stress situations. Finally, it discusses the impacts of technological improvements and modernisation on the ability of the users to collectively solve water distribution disputes and the conditions under which the modern mechanisms for fair distribution of water resources become applicable to the MENA region.

2.Mena Region

2.1 Geography and Climate

The MENA region is located between latitudes 13W and 60E and between longitudes 15N and 40N covering a surface area of about 11.1 million square kilometers or about 8% of the area of the world. Because of the prevailing arid conditions in the region, about 85% of this area is desert. The Sahara (the Great Desert), extending between the Atlantic Ocean and the Red Sea, comprises large parts of the Maghreb countries, Libya and Egypt. The Arabian Peninsula has a significant part of the desert area with the Rub Al-Khali (Empty Quarter) desert in the south and the Baidat El-Sham desert in the north. In addition, a large part of Iran is covered with desert.

Despite belonging to the same region, the countries in MENA have very different environments, resources and economies. The sub-region of North Africa extends from the Mediterranean climate zone to the arid zone. Rainfall occurs in the winter season with a clear and dry summer season. There are major differences in the climate within the sub-region between the Maghreb countries (Algeria, Libya, Morocco and Tunisia) and Egypt. The Maghreb has climates changing from north to south and a divided and dispersed hydrography (some average-sized rivers only in Morocco). Egypt has an arid climate and a simplified hydrography with very limited internal resources and only one river, the Nile River, flowing from outside its boundaries. Similarly, the sub-region of the Middle East has two different climates: the Arabian Peninsula with its desert climate that is very hot in the summer and relatively cold in the winter with very scarce rainfall and the much milder and wetter climate of the countries in the north of the sub-region (Iran, Iraq, Lebanon and Syria).

MENA was the home for 294 million people in 2004, or about 5% of the world's population, with an average annual population growth rate of 1.7% (World Bank, 2005). About 60% of the total population live in urban areas but this percentage is on the increase as people shift to urban areas in search for better economic opportunities.

2.2 Water Resources

MENA is the driest and most water scarce region in the world and this is increasingly affecting the economic and social development of most countries of the region. MENA has about 0.7% of available world's freshwater resources. Today, average per capita water availability in the region is slightly above the so-called water scarcity limit at about 1,076 m^3/year (compared to the world average of about 8,500). However, country figures vary significantly from a high of about 2,000 m^3/capita/year or more in Iran and Iraq to less than 200 m^3/capita/year in Jordan, the West Bank and Gaza, Yemen and many Gulf countries (). Generally, the north of the Middle East sub-region is the richest area in MENA in terms of water resources whereas the Arabian Peninsula is the poorest in the region.

Surface water still constitutes a main resource in the region. More than two-thirds of the 360 km^3 average total annual renewable water resources in MENA come from surface resources. These comprise rainfall, rivers, springs and lakes. Rainfall is highly variable in MENA, both quantitatively and geographically. Overall, average annual rainfall is less than 100 mm in 65% of the region, between 100 and 300 mm in 15% of the region and more than 300 mm in the remaining 20% of the region (Allam, 2002).

The main permanent rivers in MENA are the Nile in North Africa and the Tigris and Euphrates in the Middle East. The average annual Nile flow at Aswan is about 84 km^3/year, out of which more than 80% occurs between August and October. The Euphrates passes through Syria then Iraq with average annual flows of 26 and 30 km^3 as it enters Syria and Iraq respectively (Abu-Zeid, 1998). The Tigris and Euphrates join together in Iraq to form Shat El-Arab which eventually drains into the Arabian Gulf.

Besides surface water resources, there are substantial non-renewable groundwater resources in MENA. Groundwater is a very important resource for arid countries such as Algeria, Jordan, Libya, Saudi Arabia

and the United Arab Emirates. The most important groundwater aquifers are the Great Western and Eastern Ergs (veins), the Nubian Sandstone, and the Saq/Disi. The Great Western and Eastern Ergs are located south of the Atlas Mountains in Algeria and extend into Tunisia with an estimated volume of stored water of about 3,200 km^3, but only 0.03% of this volume is recharged annually (UNESCO et al., 1988). The Nubian Sandstone aquifer underlies parts of Egypt, Libya, Sudan and Chad, covering an area of 2.35 km^2 with an estimated storage volume of 15,000 km^3 (Abu-Zeid, 2002). The Saq Formation (Disi Aquifer in Jordan) covers an area of 106,000 km^2 and extends from Jordan to the east and south into Saudi Arabia.

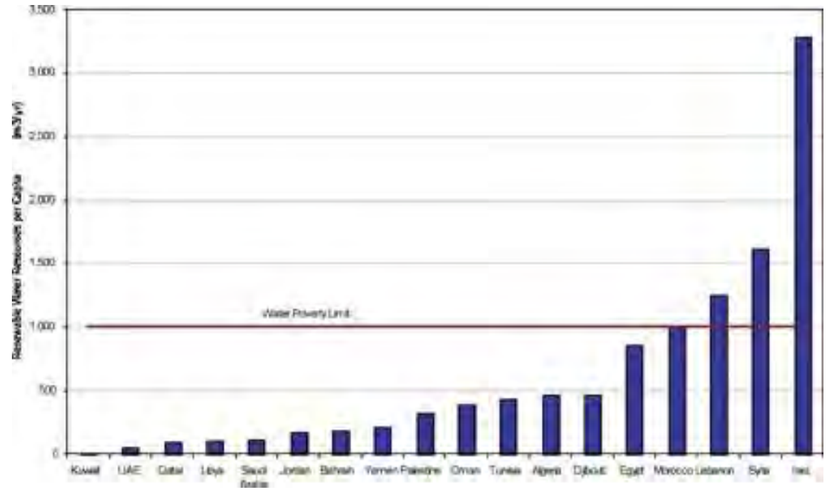


Figure1: Annual Renewable Water Resources per Capita in MENA in 2000 (Source: Abu-Zeid et al., 2004)

Because of the very limited potential for exploring new conventional water resources in MENA, both physically and economically, the use of non-conventional water resources is essential and is indeed on the increase in the region. The most common of such resources is the reuse of drainage and/or treated wastewater and water desalination. While the reuse of untreated and treated wastewater have some environmental concerns, this resource remains very important to many countries especially poor and middle income countries. On the other hand, sea water desalination is an important source of water only in the oil-rich countries in the Arabian Peninsula. Saudi Arabia alone accounts for 30 percent of the world's capacity with the rest of the Gulf States accounting for a comparable amount.

2.3 Water Use by Sector

Other than in a few desert states, irrigation is by far the predominant water user accounting for more than 85% of withdrawals in MENA (). However, this picture is likely to change gradually as demand for water increases in the rapidly expanding urban areas. Water use for domestic purposes currently comes in second place after agriculture. However, some MENA countries have recently adopted new policies encouraging industrialisation in order to improve their economies. The share of the industrial sector can be expected to increase in the future, although in many cases industry is not a water consumer but a water user.

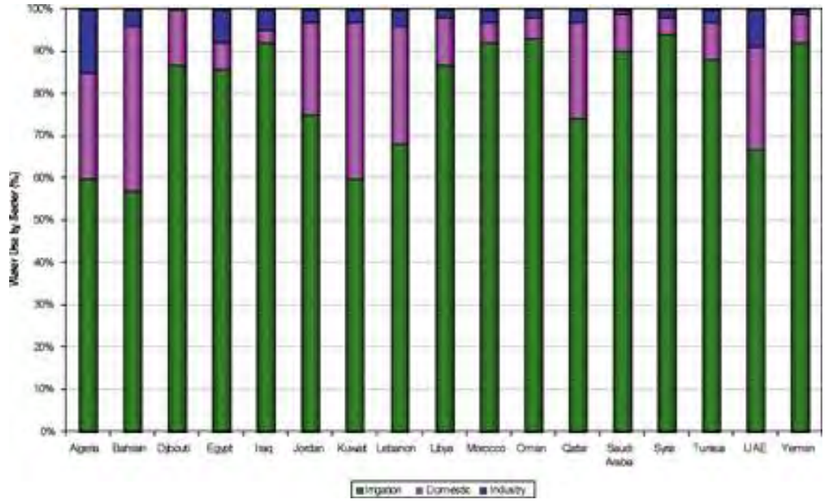


Figure 2: Water Use by Sector in MENA in 2000 (Source: Abu-Zeid et al., 2004)

3. Water Conflicts and Conflicts Resolution Mechanisms

This section reviews the water conflicts and disputes in the MENA region at the sub-national level. The information presented in this section is collected from the literature and derived from the country case studies which are presented later in Section . In fact, a review of the literature available on the subject revealed how little it is. Most of the available literature deals with transboundary and inter-state water related conflicts, especially those in the main river basins in the region. In this respect, this study is a pioneer in focusing on water conflicts at the macro and micro levels within the individual countries in the region.

3.1 Water Conflicts

Conflict is a natural disagreement resulting from individuals or groups differing in attitudes, beliefs, values, or needs. Conflicts in water management often involve interactions between various factors, water sub-sectors, and stakeholders in the water resources management process (Nandalal & Simonovic, undated).

The type and severity of water conflicts may vary depending on the region where the conflicts take place. In non-arid regions, water disputes and conflicts are usually related to development activities resulting in environmental concerns such as dam construction or transboundary pollution.
On the other hand, in arid and semi-arid regions, water disputes and conflicts are chiefly related to the problem of water scarcity, although they may also involve similar issues relating to development activities.

3.2 Water Conflicts Trend

It is difficult to preciously follow the trend of water conflicts, especially those at the sub-national level in MENA, because of the little literature and documentation available on this subject. However, because the main source of water conflicts in the region is the increasing scarcity of the resource due to the rapid growth in the population, it can be reasonably assumed that the trend of water conflicts follows that of scarcity.
The annual per capita availability of freshwater in the region dropped by two-thirds between 1960 and 1995 falling from 3,300 to less than 1,250 cubic metres (World Bank, 1997). Water availability in MENA is expected to halve over the next 25 years if the present pattern of use continues.
Many speculations about future conflicts over water in the region have been made by various analysts. Some suggested that the region's next war will be fought over water.

Others tried to establish explicit and implicit links between water scarcity and regional security. But this trend of a rising rate of disputes and conflicts over water is not unique to MENA; Wolf (2002) notes that despite of the past negotiation efforts, conflicts linked to freshwater still exist at various international levels, and the risk for more grows as population and degradation pressures accelerate.

3.3 Causes of Water Conflicts

Generally, conflicts over a resource are associated with its scarcity and hence competition on the resource. When the resource is ample, unlawful acts by a group of users is unlikely to show vivid negative impacts on the rest of the users, at least on the short run. It is scarcity and competition that trigger tensions leading to disputes and conflicts. It can therefore be envisaged that the causes of water scarcity are largely the sources of conflicts. In fact water scarcity is not only a source of conflict but is also a challenge to the planners, managers and operators of the resource. In addition to water scarcity, other challenges facing water resources management in MENA also lead to conflicts.

3.3.1 Shortage of Supply

In MENA as a whole, actual water withdrawals in 2000 amounted to 263 km^3 or about 73 percent of the annual renewable resources (WRI, 2005). However, country level figures portray a different picture (). Most countries in the dry areas; notably Egypt, Jordan and those in the Arabian Peninsula are already exploiting all or exceeding their renewable water resources. As a consequence, groundwater reserves are being rapidly depleted, at least outside the major river valleys of the Nile and the Tigris/Euphrates. It is already the only or the predominant source of supply in some countries such as Saudi Arabia and the Gulf States. Over-pumping has led to rapid declines in the water tables in many locations. Such rapid declines in groundwater levels render many locations uneconomic for exploitation.

3.3.2 Water Pollution

Supply shortage is not only in quantitative terms but can also be qualitative. According to the UNDP (2003), 15 percent of the total population in MENA lack access to safe domestic water leading to health hazards and high mortality rates among children. In some countries the figure can be up to 50 percent. Most of the deprived population are the poor in rural areas. Pollution of surface and shallow ground water resources due to the disposal of untreated agricultural, industrial and urban waste is affecting public health, ecosystems, productivity of resources and quality of life. Siltation and eutrophication of lakes and dam reservoirs are also

common problems. Over-abstraction of groundwater causes sea water intrusion leading to salinisation of wells and loss of agricultural land.

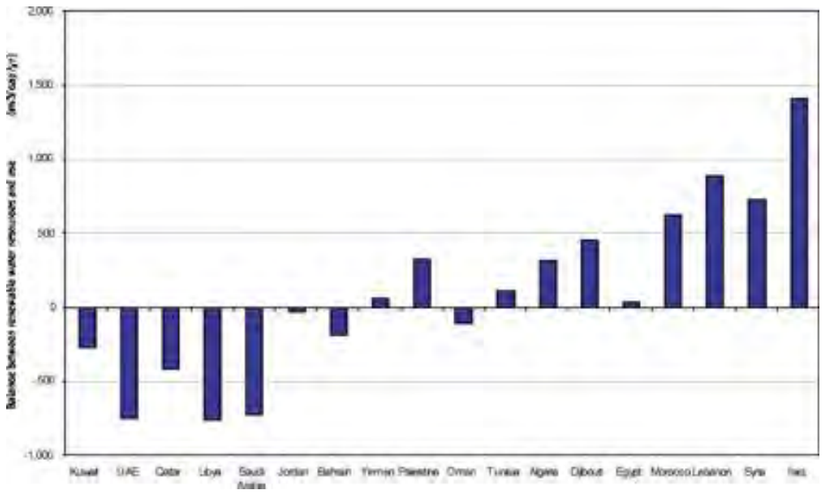


Figure 3: Balance between Renewable Water Resources and Water Use in MENA in 2000 (Source: Abu-Zeid et al., 2004)

3.3.3 Variability of Resources

The water scarcity problem in MENA is accentuated by the high seasonal and spatial variability of water resources. Annual precipitation varies from negligible amounts in desert areas to more than 1,500 mm in some mountainous regions with most rain falling in the winter months. Areas of moderate rainfall (500-750 mm) include Lebanon, most of northern and western Iran and the Maghreb as far inland as the southern slopes of the Atlas Mountains. Stream flows are similarly affected and vary markedly during the year in response to rainfall/runoff patterns. Discharges in the low-flow summer season typically average from one-fifth to one-tenth of those in the high-flow winter season. Actual water availability therefore fluctuates considerably about the averages. The problem has been exacerbated by the consecutive droughts in the region over the last two decades.

3.3.4 High Demands

In spite of the relatively low population growth rates in recent years, demand for water in MENA is steadily increasing at alarming rates. Large population increases do not only generate higher demands for drinking water, but also need more food which in turn requires more water for agriculture if food security levels are to be maintained. Egypt, Iran, Iraq, and Morocco have been implementing irrigation development projects to bring more land under irrigated agriculture. Farmers tend to grow high water consuming crops if they earn them more cash. Living conditions and standards have been rising in many urban areas in the region contributing to the higher demands for water. On the other hand, water-service charges, if any, in most MENA countries are not based on actual consumption but on flat rates and hence do not function as water rationalisation tools.

3.3.5 Low Water Use Efficiencies

Agriculture is the highest water consumer among all sectors. Irrigation in the main river basins uses mainly surface methods that typically have very low application efficiencies. In addition, irrigation generates water losses through evaporation, seepage and deep percolation. Although a large part of this water can be recovered and reused enhancing the overall water use efficiency, the quality of the recovered water is usually low which adversely affects crop production and causes soil salinisation.

Nonetheless, the other sectors also need to increase their water use efficiencies. Domestic water supply systems are old and are not properly maintained resulting in high losses. In addition, significant quantities of water are sometimes abstracted by illegal connections. It is estimated that 30 percent or more of the water supply in the domestic networks is lost or is unaccounted for (Liemberger and Bessey, 1998). The industrial sector is known for generating highly-polluted wastewater that is not properly treated prohibiting its reuse.

3.3.6 Inadequate Institutional and Legislative Frameworks

The institutional setup in the water sector is characterised in many MENA countries by inadequacy and lack of harmony. This is related to the multiplicity of water authorities and hence their overlapping and conflicting functions. Moreover, there is a shortage of skills and capacity to develop and manage water resources.

On the other hand, most of the existing water legislations, rules and regulations in the region are quite old and need to be revised and updated in order to meet today's needs. Even the more recent legislations still suffer from gaps and ambiguities that they may cause conflicts instead of preventing them. The judicial system is very slow and bureaucratic, in contradiction to the nature of most water conflicts which need immediate action. Long unresolved conflicts can easily escalate, leading people to take matters into their own hands which complicates things further.

3.3.7 Improper Governance and Centralization

Governments in the MENA region were, and to a large extent still are, heavily involved in developing, managing and operating most water services down to the micro level. With the growing demand for extending and expanding these services to meet the needs of the populations, most governments started to recognize the need for decentralization so that decisions can be made at the lower levels with stakeholders participation. This will enable the local authorities and stakeholders to play a more effective role in planning and managing the resources locally and will improve their awareness of the water-related challenges.

3.3.8 Water Tariffs

The linkage between water tariffs and water conflicts is controversial. Nonetheless, it has been demonstrated through many case studies that water tariffs were a main source of conflict, especially between user groups and sectors on one side and governments on the other side (Abdellaoui, 2005 & Shatanawi, 2005). Users usually object to water tariffing when it is first introduced or complain when the tariffs are raised on the ground that water tariffing add to the already high input costs of their activities. Some even go farther and reject water tariffing on religious grounds that water is a free gift of God and therefore should not paid for. However, water tariffing is never meant for selling water; it is a means of recovering part of the cost of service.

3.3.9 Lack of Funds

Most water services are still largely governmental. Large-scale irrigation projects are one such an example. The steady increase in the annual expenditure on operation and maintenance of those services have overwhelmed and strained the budgets of many countries. Water-service charges are still far from recovering the actual cost of the services. Moreover, actual collection rates are in some cases very low. Consequently, many services still remain heavily subsidised by public money. The allocated funds are much less than the required investments. As a result, the water infrastructure is deteriorating rapidly leading to frequent interruptions and failures in the services, increased water losses and inaccurate water distribution to the users.

3.3.10 Unplanned Change in Water Management Schemes

Often times, unplanned change in policies and incentive systems help create rather than resolve conflict. Such situations are definitely not intentional but result from inadequate understanding of the problems, improper

assessment of the potential impacts and poor skills of the planners and technicians. Several case studies demonstrate such mistakes. In Egypt, the government decided to lower the water levels in the canals such that farmers had to lift water to their fields. The idea was that farmers would rationalise on water use if they had to pay for water pumping. The truth was that the introduction of mobile diesel pumps in the agricultural sector in Egypt caused a series of problems: 1) the informal farmer organisations in saqya groups gradually disappeared as each individual farmer bought his own pump set, 2) irrigation became an individualistic activity and hence competition on water became very fierce as farmers no more scheduled irrigation among themselves, 3) the installed lifting capacity of the pumping units far exceeded the carrying capacity of the feeder canal causing severe water shortages in the tail ends, and 4) subsidised fuel prices meant that the cost of water pumping was not a prohibiting factor for misuse of water (Hartveld & Madbouli, 2004). Various actions have been taken to correct these problems including the formation of water user organisations in order to schedule irrigation turns among farmers and gradually removing fuel subsidies.

In Yemen, agricultural programs that have pushed farmers to invest in groundwater for cash crops are creating conflictual situations. The promotion of oranges and pomegranates in Sa'ada over twenty years through subsidies and protection has bound farmers to a huge long term investment in a tree crop that cannot now be sustained by the water resources in many places. A similar pattern is arising with the mango groves at Abs, promoted by public subsidy for drip irrigation and for which the water resources are rapidly being depleted (Bazza, 1999). Development of the catchment areas of spate irrigation schemes for rainfall harvesting and rainfed agriculture have inverse impacts on water availability in the downstream wadis and hence on the future of spate irrigation.

3.3.11 Inadequate Water Users Participation

Perhaps one of the causes of conflict in the water-using sectors that is not directly related to water itself is the non-participation of some users in communal activities. The most frequent case is the refusal of some farmers to participate in the maintenance of the common irrigation canals and drains that supply water to their fields. Although typically some government organisations are responsible for O&M of the irrigation networks of most medium to large-scale schemes, farmers are usually responsible for carrying out simple maintenance activities at the low-end of the system. They either participate by physically carrying out the maintenance work or by sharing the cost of hiring labour or contractors to do the work. Refusing to participate has many reasons such as the inability of poor farmers to pay their shares of the maintenance cost (Piran, 2005). In addition, farmers located at the upstream-end of irrigation canals are reluctant to participate in canal maintenance because for them maintaining the canals mainly benefits those located downstream. Although water laws usually include provisions for dealing with such cases, law enforcement is generally another problem. This task is therefore better dealt with through water user organisations.

3.3.12 Socio-economic Conditions

The socio-economic conditions can also play a role in raising disputes and conflicts. Unemployment, for example, makes young men frustrated and perhaps angry at the society in general as they blame it for failing to secure work opportunities for them. Those young men usually loose patience quickly and hence small disputes in which they get involved can easily escalate. For them, being involved in any activity, even a fight or a violent act, is better than sitting idle at home! (Al-Shaybani & Al-Zubayri, 2005).

3.3.13 Inadequate Public Awareness

Public awareness constitutes an important active tool complementary to other technical means pertaining to the conservation and the rational utilisation of water resources and the minimisation of related conflicts. The inadequacy of public awareness coupled with lack of access to correct and complete information make the public opinion prone to be easily misguided. Rumours and false news can all cause disputes and conflicts between various groups of people. Usually, such acts are motivated by personal and political interests rather than being based on facts.

3.4 Types of Competition on Water

Competition on water can have different types and shapes, including:

3.4.1 Upstream vs. Downstream

Perhaps the oldest and most frequent type of competition is that between upstream and downstream users sharing the same source of water. Consequently, this type of competition is mainly associated with water conveyance and distribution systems where water flows from the upstream to the downstream end (e.g. rivers, canals, wadi systems, streams, pipelines, etc.). Typically, the upstream users are always accused of over-using the water or taking more than their fair share, by for example continuously enlarging the area of land irrigated from the water source or growing high-water-consuming crops. Such a case is very well documented in many spate irrigation schemes in Yemen where the upstream farmers shifted to growing bananas for their high cash returns hence taking much more than their fair share of water.

This type of competition is usually assisted by the following factors: 1) it is technically very difficult to prevent the upstream users from over-using water but this can only be accomplished through formal or informal water user organisations, 2) the price of the agricultural land that is irrigated from the upstream reaches of water sources is usually higher than that of the land irrigated from the downstream reaches, hence typically upstream water users are richer and of higher social status than downstream users, and 3) because of better water availability in the upstream areas, farmers in those areas are able to grow more cash crops thus reinforcing their financial and social status in the community which helps them use more water and deprive others in the tail ends.

3.4.2 Surface vs. Groundwater

The competition between surface and groundwater is interchangeable: development of catchment areas for rainfall harvesting, rainfed agriculture or diversion of run off flows can reduce the rate of groundwater recharge for downstream users and hence deplete the resource. On the contrary, over-use of groundwater can deplete springs. The hydrological connectivity between surface and groundwater resources are sometimes not clear to the non-expert because of the large distances that sometimes separate the two sources.

Conflicts over surface water resources are usually easier to resolve since the problem is easier to "see" than conflicts over groundwater. In addition, surface water principles are also easier for the non-professional to grasp on the contrary to groundwater principles which require knowledge and experience.

3.4.3 Competition between Groundwater Wells

The interference between nearby groundwater wells is a technical fact that is fully known not only to technicians but also to most groundwater users. Setting a fixed minimum spacing between wells that take water from the same aquifer is one of the simplest methods to avoid or minimise interference. For example, in Yemen this has been determined as 500 m. However, in some cases it may not be possible to respect the minimum well spacing because of land shapes and dimensions: two neighbouring farmers or communities might want to have their separate wells which will be too close to each other because of the proximity of the irrigated lands or villages. One case study from Yemen demonstrates such a problem when a farmer was forced by the whole community to fill in his illegally dug well. Well licensing is also another mean of preventing such type of competition.

3.4.4 Competition between Water Use Sectors

Competition between the various water-user sectors is also on the increase. Agriculture, the main water user, has always been accused of being the least efficient sector with respect to water use. Growing populations and the move to industrialisation in many MENA countries all put pressure to increase the water shares of these sectors at the expense of agriculture. For instance, many wells around Yemeni cities like Ta'iz and Sana'a (which gets two thirds of its water from private wells) are wholly or partly converted to urban water supply for profit. The same type of competition also exists between the different types of water users at the lower level. In Yemen, communities in the Ta'iz region keep an eye on the activities of local farmers and have stopped the digging of many new wells in order to protect their potable water supply. Water is essential for life so when water is very short, drinking water becomes top priority over other uses.

3.5 Conflict Management and Resolution Mechanisms

3.5.1 Social Factors

Perhaps among the most important and efficient mechanisms for conflict resolution in MENA are the social factors. This is related to the fact that many countries in the region have very long historical backgrounds and civilisations upon which current customs and values are built. The social customs, values and traditions are not only important conflict resolution mechanisms; they are also key factors in determining the level of conflict escalation. For instance, conflicts can quickly arise and escalate to violence in the Yemeni rural areas where tribal values of honour, shame and revenge drive behaviour (Ward, 2005). On the contrary, communal values and kinship ties in rural Egypt and Iran are indeed very important factors in confining disputes and conflicts within the boundaries of the community and preventing them from escalation (Mohieddin, 2005; Piran, 2005).

It is for the above reasons that conflict resolution in the rural areas is still being primarily done through community and local leaders instead of resorting to the authorities or to the judicial system.

3.5.2 Customary Rules and Regulations

Because agriculture is such an ancient activity in many areas in MENA, the local communities associated with this activity have developed their own customary rules and regulations to control and manage the process. Together with the social customs, traditions and values; the customary rules and regulations currently constitute the main conflict resolution mechanisms in the rural areas of MENA.

3.5.3 Legislation Enforcement

The legislation should the fundamental reference for conflict resolution. However, the water legislation in some countries in MENA is quite old and is therefore largely incompetent to meet the challenges of today's disputes and conflicts. In this respect, the modernisation and updating of the water legislation has recently been or currently is a main activity in the water sector and the legislature. For example, the water legislation in Morocco was updated by the issuance of Law 10/1995. In Egypt, the Irrigation and Drainage Law 12 of 1984 was amended by Law 213 of 1994 in order to legalise the establishment of water user associations and define their roles. In addition, the Law has been under complete revision since 1999 in order to be able to meet the requirements of modern water management challenges.

3.5.4 User Participation

For conflicts which involve the users, either among themselves or with other institutions, it is important to similarly involve the users in the conflict resolution process. This approach is known as user participation. It aims at the appropriation of the decisions by the parties in conflict, which facilitates the acceptance of the reached agreements and ensures the sustainability of the solutions.

A pre-requisite for getting the users involved in decision-making and conflict resolution is to provide them with complete information about the problems under consideration. In addition, the "rules of the game" must be clearly established in terms of laws, regulations, rules, standards, etc. (Bzioui, 2005). Moreover, a good moderator; whether a government organization or a local leader, with good communication skills is required to help the parties in conflict reach an agreement not continue arguing escalating the conflict. Such pre-requisites should facilitate the fast conclusion of agreements.

A key issue in participatory approaches is not to impose any ideas or solutions on the users. When the beneficiaries themselves come up with ideas and solutions to potential or existing problems, it is very likely that those solutions will be accepted by the larger community and will be sustainable. However, stakeholders that could be affected by local decisions should also be involved.

User participation does not necessarily have to be through formal user organisations; informal user groups or organisations can be equally suitable for such tasks provided that they are accepted by the communities which they represent. Nonetheless, formal user organisations, such as water user associations in the agricultural sector, should provide more efficient means for user participation and conflict resolution.

4.Country Case Studies

Following a review of water conflicts in the MENA region in general in the previous section, the purpose of this section is to provide more insights of the problem through the presentation of five country case studies in addition to a brief case about Djibouti. However, the country case studies presented in this section are only summaries of the full country reports. For more detailed information on the country case studies, the reader is referred to the country reports as follows: Egypt (Attia, 2005; Barakat, 2005; Mohieddin, 2005), Iran (Piran, 2005), Jordan (Shatanawi, 2005), Morocco (Abdellaoui, 2005; Bzioui, 2005) and Yemen (Ward, 2005; Al-Shaybani & Al-Zubayri, 2005).

4.1 Egypt

Egypt is located in the arid zone of North Africa. Its annual renewable water resources are limited to the fixed share of the Nile water of 55.5 billion cubic meters per year. Rainfall is very scarce and scattered and only occurs along a narrow strip along the northern Mediterranean coasts. Groundwater in the eastern and western deserts is mostly non-renewable; however, it can be developed at high economic costs.

Total population of Egypt is currently estimated at 72 millions (2005). This large population is concentrated on the fertile lands of the Nile Valley and Delta, occupying just about 4% of the country's total area of about 1 million km2.

Agriculture is one of the main activities in Egypt and supports a large amount of employment. It used to be and mostly still is subsistence agriculture as land holdings are very small. Agriculture is primarily irrigated consuming about 85% of the annual water use.
However, the flourishing industrial sector and increasing population are putting pressure to increase their current water share of 15% of total resources. The agriculture sector is the sector with the highest potential for achieving real water savings, where a small increase in water use efficiency can contribute to large amounts of water savings. It is important to mention that a large part of this water use efficiency could be achieved by reducing local water conflicts among users in the agriculture sector.

For the above reasons, all the case studies from Egypt have been selected from the agricultural sector. They represent some of the different ecological and social systems that exist in this important sector.

4.1.1 Sources of Water Conflicts

Water conflicts in the agricultural sector in Egypt can usually be attributed to canal water shortages, especially during the periods of peak water demands in the middle of the summer season. Canal water shortages are not necessarily due to supply shortages, but can be due to uneven distribution of water supplies. Farmers at the canal head reaches typically take more than their fair share of canal water depriving those at the tail reaches. Growing large areas of high-water-consumption crops (rice in the Delta and sugar cane in Upper Egypt) also adds to the problem.

4.1.2 Conflict Resolution Mechanisms

Different mechanisms are used to resolve water conflicts depending on their type, scale and the parties involved. The most common of those mechanisms largely depends on the intervention of the local community leaders based on customary laws. The social aspects such as kinship ties between the water users play an important role not only in conflict resolution but in minimising the conflicts at the first place. These are more profound in the Nile Valley and Delta.

The following case studies illustrate some of the water conflict resolution mechanisms in the agricultural sector.

4.1.3 Case Study 1: The Saqya System

Prior to the construction of the High Aswan Dam (HAD) in 1960 the irrigation system in Egypt used to be fully gravitational where water in the canals was the factor influencing the lands to be irrigated. After HAD, the Ministry of Water Resources and Irrigation (MWRI) decided to lower the water levels in the distribution canals such that farmers had to lift the water to their fields. The decision was made based on the assumption that if farmers had to lift water instead of taking it freely by gravity they would use it more rationally. HAD also provided full control of the Nile flood water which made all year-round cultivation possible raising cropping intensities to 200%.

Consequently, farmers who once used to irrigate their lands by gravity or using Archimedes' screws (tambour) found themselves confronted with the fact that they had to lift the water. Nonetheless, lifting heads were small which suited the use of water wheels (saqias) as lifting devices. They were simple wooden structures operated by animal power. Saqias lifted the water from the tertiary canals (mesqas) to the field ditches (marwas) from which it was diverted by gravity to the fields. Because of their small discharges a saqya could serve between eight to 12 farmers. Consequently, large tertiary canals had more than one saqya according to the number of farmers who depended on the canal for irrigation.

Saqias prevailed during the 1970s and early 1980s until they were gradually replaced with mobile pumping units. Nowadays, there are very few saqias still in operation. One such a location where saqias are still in service is a small village in Menoufia Governorate in Middle Delta. The village has a total population of 2000 inhabitants forming 385 households. The total irrigated area is 120 feddans mainly cultivated with subsistence crops such as maize in the summer and wheat and berseem in the winter.

The village gets its irrigation water from the Rosetta Branch of the River Nile through a network of primary, main, secondary and tertiary canals. Originally, 21 saqias lifted the water from the tertiary canals to the farm ditches to irrigate the 120 feddans in the village. Currently, only 12 saqias are still in operation irrigating 67 feddans only. The remaining saqias are broken and farmers preferred to change to using mobile diesel pumps instead of repairing them.

The responsibility of operating and maintaining the irrigation network down to the tertiary canals lies with MWRI as this part of the system is considered public property. Below this level the system is considered private property of the farmers and hence they assume its responsibility. The saqias are collectively owned by the farmers who depend on it for irrigation, thus they share its capital and maintenance costs. They also take the responsibility of cleaning and maintaining the field ditches. However, every farmer usually maintains the part of the field ditch which runs in his land. As such the maintenance of the field ditches is less collective compared to that of the saqias.

The farmers on the saqias organise themselves into informal groups and select leaders (sheikhs) to the saqias. The saqya leaders are usually selected based on many factors including ownership of the largest share in the saqya, proximity of residence to the saqya site, social status, honesty, age seniority, having spare time to voluntarily tend to saqya matters and ownership of the land on which the saqya is located. The saqya leaders assume certain responsibilities, the most important of which are: organizing irrigation turns (schedule), settling disputes over irrigation turns among the shareholders in the saqias and collecting the money required for maintaining or replacing the saqias.

Each farmer in a group has a share in its saqya which should be proportional to the land holding. It is this share that determines the farmer's share in the saqya operation time (irrigation duration), money for maintenance, etc. There are no rules however to organise irrigation turns on the saqya. The farmer who needs to irrigate must inform the saqya leader one day in advance. If that time is already booked by another farmer, then (s)he must ask the permission of that farmer to irrigate first or just has to wait until (s)he finishes. Most conflicts on the saqya occur because of irrigation turns and times. Farmers usually prefer to irrigate early or late in the day in order to avoid the strong heat of mid day particularly in the summer season. The other main causes of disputes on the saqya are: bypassing the irrigation turn, irrigating without informing the leader, booking a block of time for irrigation and not using it, and continuing to irrigate beyond the allocated time while another farmer waits to start his/her turn. On the other hand, clashes also occur when farmers do not maintain the field ditches in their lands causing irrigation water to flood neighbouring lands.

The farmers in this research site have had very few complaints about irrigation water this summer (2005) as they reported that the water was available in sufficient quantities and on time. However, over the past five years they had all kinds of problems because water was short and unpredictable. Nonetheless, conflict over irrigation water seldom leads to violence. Most disputes do not exceed the exchange of harsh words.

The saqya leaders are usually key players in settling the disputes by holding customary councils to condemn the wrong doers, oblige them to apologize to the complainers and instruct them not to violate the rules again. If the assailant does not submit to the decision of the council, or if there is a case of severe injury then the village mayor is informed and can turn the matter to the police.

In case of water supply shortage in the canals, the farmers resort to complaining to the irrigation agency by writing complaints to MWRI's head quarters in Cairo.

There are several factors that inhibit dispute or severe conflict over water in this village, which are not unique to this case. The most important of which is kinship ties which virtually connect all the saqya stakeholders together. A severe case of physical assault will have serious consequences on such ties. Farmers therefore prefer to avoid any disputes and try to cope with water-related problems by all means. Another factor is the introduction of mobile diesel pumps in the village in place of some broken saqias which allowed farmers to use drainage water in times of severe canal water shortage instead of fighting for canal water with their saqya neighbours. Although diesel pumps may have created some conflicts over canal water sufficiency for saqya users, it contributed to reducing some conflicts due to their mobility factor that allowed for using drainage water in times of water shortages.

4.1.4 Case Study 2: Traditional Tertiary Canals/Individual Pumping Units

As mentioned above, saqias prevailed during the 1970s and early 1980s as water lifting devices until they were gradually replaced with mobile diesel pumping units. Initially the cost of the pumps was high that only better-off farmers could afford it. With the advancement in technology, pump prices came down and more farmers made the move. Nowadays, almost all farmers in the Old Lands[1] in Egypt use mobile diesel pumps to lift water from the tertiary canals to the field ditches.

Farmers preferred to shift from the saqya and other simple lifting devices such as the Archimedes screw (tambour) to the mobile pumps for many reasons: 1) the pump saves time and animal effort as farmers report that the pump takes only one third of the time taken by the saqya to irrigate the same area of land. Reducing the irrigation time has become very important to many village residents as agriculture for them has become a second job besides being government employees. 2) The pump gives the farmers the freedom to take water from different sources so when there is water shortage in the canals the farmers can use the drains instead. 3) The pump saves the area allocated to the saqya site, which despite being relatively small still have a considerable value in a country like Egypt where agricultural land prices are very high.

The location of this case study is a village in Menya Governorate in Middle Egypt where farmers use mobile pumps for irrigation. The village has a total population of 43919 and an irrigated area of 3835 feddans. Agriculture is mainly for subsistence, i.e. farmers are mostly small holders who grow crops for feeding their families. The main crops being berseem and wheat in the winter and maize in the summer. The village gets its irrigation water from Ibrahimia canal through a series of main, secondary and tertiary canals. The canals below the main level operate under rotational supply, i.e. water is not available in the canals all the time. Farmers cannot therefore irrigate except when it is the turn of their canal to have water, or otherwise have to use other sources for irrigation water.

Most of the farmers in the village now own irrigation pumps. For example, there are 200 pump units on one of the tertiary canals that commands 591 feddans held by 600 farmers. This suggests that some of the pumps might be owned by more than one farmer or some farmers rent the pumps for irrigation. The cost of renting the pumps is about LE 20 per feddan.

Unlike the saqya system which required organisation and collaboration between its farmer groups, mobile diesel pumps do not encourage such informal farmer organisations. Irrigation becomes an individualistic activity under this system. In the absence of any organisation or rules to manage irrigation, it is not surprising that this system leads to many disputes and conflicts among the farmers.

Farmers in the village reported frequent absolute water shortages in the canals. High degree of uncertainty and variability in the water supply and lack of predictability

[1] The "Old Lands" refers to the Nile Valley and Delta in Egypt.

in the system causes irrigation frenzy whenever water is available, especially during daytime, leading to disputes and sometimes open conflict. Compared to the saqya which controlled the number of farmers who can irrigate at one point in time, the mobile pump has enabled a large number of farmers to irrigate at the same time. When there is water in the tertiary canal, any farmer who wishes to irrigate can operate his pump and lift water from the canal to the field ditch. The abstraction capacities from the tertiary canals therefore significantly increased whereas their carrying capacities remained the same, thus leading to a deficiency in the balance between the supply and the demand. It is thus possible to argue that it is not only the shortage in water supply that is responsible for the problem, but also the technological development coupled with farmer behaviour.

It seems however that farmers are not equally subject to the same degree of water shortage. A big landlord in the village reported that he had had very few problems with water, and had devised his own means to counteract water shortage. One way of doing this is to depend on underground water to supplement canal water. But digging a well is costly and only the well to do can afford it. Yet, rich farmers allow neighbouring small farmers to use their wells for free, provided they use their own pumps. Such a free service helps rich farmers reinforce their status in the community. Thus irrigation contributes to the reproduction of the traditional social structure of power, loyalty and submission.

Other farmers try to overcome canal water shortage by renting an additional pump to increase the amount of water drawn into their fields and shorten the irrigation time. Some choose to cultivate crops that do not require too much water such as cumin. Poor farmers who are less fortunate, such as not being close to a well, are left with very little but to use drainage water if they have mobile diesel pumps.

Other forms of dispute among the farmers include fighting for irrigation water and turns and blocking the water courses in order to divert as much water as possible. Arguments usually involve harsh words and cursing. Most disputes are resolved either through direct negotiations or customary law. Sometimes, village leaders intervene to curtail the potential escalation of the problems. However, some incidents escalate to physical assault and may result in injuries. Such cases are usually locally resolved according to customary law. A slap on the face is worth a symbolic LE 1000 which the offender pays in public. A portion of this money is used for treatment, another is donated to the mosque/church, and whatever remains is returned to the offender. Resorting to violence or to the police appears to be a last choice among farmers, except in cases of severe injuries requiring hospitalization. In other cases kinship ties are used as a mechanism to settle disputes or conflicts over water.

4.1.5 Case Study 3: Improved Tertiary Canals/Water User Associations

Another case study is at a village in Menya Governorate in Middle Egypt. However, this case study has a major difference from the previous one in terms of irrigation organisation and management. The Irrigation Improvement Project (IIP) was introduced to the village in 1995 as a grant from USAID. Generally, the IIP introduces both hard and soft interventions at the delivery and tertiary system levels. Delivery system improvements include changing the operation schedule of the branch canals from rotational supply to continuous flow. Such a change requires the introduction of modern control structures in the branch canals. Hardware interventions at the tertiary level comprise the construction of a collective pumping station (single-point lifting) at the head of each tertiary canal and replacing the old earth canals with either elevated lined canals (prefabricated concrete "J" sections) or low pressure buried pipelines with alfalfa valves as outlets. Thirty three tertiary canals were improved in the village, 11 as pipelines and 22 as elevated lined canals. They irrigate an area of about 1849 feddans.

The IIP package requires a relatively high level of social organisation between the farmers, who should take the responsibility of operating and maintaining the improved tertiary canals and collective pumping stations, scheduling irrigation among the water users, recovering pump operation costs and resolving conflicts among the users. Accordingly, the IIP assists the farmers in establishing different types of water user organisations such as Water User Associations (WUAs) at the tertiary canal level and Branch Canal Water User Associations (BCWUAs) at the branch canal level. So in essence, the IIP is trying to revive the informal saqya groups in the form of formal water user groups.

Prior to the IIP, the farmers in the village used mobile diesel pumps to lift water for irrigation. They had to lift the water twice, from the branch canals or the wells to the tertiary canals and then to the field ditches. About 55% of the farmers owned their own pumps. So while the carrying capacity of the canals remained constant, the ability to lift increasing amounts of water due to mechanization increased disproportionately. Coupled with the rotation system, this meant a tighter time of water availability. With farmers deserting night irrigation for various reasons, not the least of which their willingness to follow TV programs at night, irrigation was intensified during daytime thus leading to more fierce competition and conflicts. The tail-end farmers suffered the most.

Prior to the IIP, farmers then had to use supplementary water sources to cover canal water shortage. Twenty one illegally dug wells distributed over 10 agricultural basins were used for supplementary water in 55% of the cases whereas drainage water accounted for 2.5% only. Other means included putting pressure on the irrigation engineer to provide more canal water (12.5% of the cases), growing crops with low water requirements (2.5% of the cases) and bribing the canal gate keeper in order to get more water.

Under such conditions prior to the IIP, water conflicts were rampant and assumed various forms ranging from the exchange of harsh words, to fist fights, beating and injuring the other party to killing in some rare instances. In case of conflict other than killing, customary law was the most common mode of conflict resolution. The village mayor, some elderly people and village leaders were usually involved in settling the disputes where a sentence would be issued against the aggressor including a financial penalty.

This picture was remarkably changed after the IIP. The consensus of the farmers is that there is no problem with water supply nowadays after the system of continuous flow replaced the old rotation system. Drainage water is almost not used for irrigation completely in the village. Differences in access to water between head and tail-enders have diminished and are now negligible in terms of their impact on crop yield. The same applies to the difference between rich and poor farmers, although rich farmers are said to have priority in irrigation turns as they irrigate first.

Accordingly, there are fewer disputes and less conflict over water after the IIP. Nonetheless, farmers still think that the WUAs are not carrying out their roles. They do not schedule irrigation among users, do not try to reduce demand for water by planning the cropping patterns with the users and do not have a significant role in conflict resolution. In fact, farmers regard the WUA's board and its decisions as unbinding. In most cases they do not resort to the board to resolve conflicts. Instead, they depend on neighbours, older people or some leaders to settle the issue regardless of being members in the board or not.

4.1.6 Case Study 4: Branch Canal Water User Associations

This case study concerns two villages, the 10th of Ramadan and Matareia, which are located in the northeastern part of the Nile Delta south of Lake Manzala in Port Said. The irrigation system and practices in these villages are typical of those in the rest of the Delta (see previous case studies). However, the villages also have some special characteristics for which they were chosen as a case study:

- Being in the tail-end of the national irrigation network, water supply shortage is commonly encountered during the hot summer months of peak demands for irrigation water.
- The main crops grown in the area are maize, wheat and sugar beet. In addition, rice was recently introduced in the area.
- The farmers, or rather water users, are diversified: there are the traditional small-holder farmers, young university graduates who receive small plots of land from the government and investors with large land holdings.
- Water user organisations have been established in the area since 2000. These include Water User Unions (WUUs) at the tertiary canal level (mesqa) and Branch Canal Water User Associations (BCWUAs) at the branch canal level (see details in).

One particular objective of this case study was to find out the exact role of BCWUAs and to test their efficiency in conflict resolution. A sample comprising 82 water users was randomly selected, 44 in the village of 10th of Ramadan representing 11% of the total users and 38 in the village of Matareia representing 12% of the total users. The sample users were interviewed using questionnaires. Data collected through the questionnaires was analysed and the results were compared with those from a previous study which addressed the same issues a few years ago before the BCWUAs were established.

Table1: Water User Organisations in the Northeastern Nile Delta (Egypt)

BCWUA (Village)	**10th of Ramadan**	Radwan	Khaled Ben Walid	Tarek Ben Zeyad	Bahr Bakar	**Matareia**
Location	**South Port Said**	South Port Said	South Huseneia	South Huseneia	South Port Said	**Matareia**
Branch canal	**No. 3**	No. 5	No. 1	No. 2	No. 1	**No. 1**
Main canal	**Om Reesh**	Om Reesh	Stage 2 canal	Stage 3 canal	Shader Azzam	**Ganabeia of Matareia**
Canal length	**4.5 km**	4.2 km	2.1 km	2 km	4 km	**4.75 km**
Area (fed.)	**1700**	1665	380	768	1400	**2560**
No. of tertiary canals	**18**	23	7	12	5	**21**
No. of WUUs	**18**	23	7	12	5	**21**
Beneficiaries	**340**	349	86	156	200 families	**600 families**

The study revealed that water conflicts in the area existed at different levels and between different groups of people. They were mainly due to irrigation water shortage during the periods of peak demands. The specific causes of such conflicts are:

- Irrigation priority.
- Time of irrigation.
- Water overuse by the upstream farmers leaving very little to those in the downstream.
- Over pumping: some farmers use pumps with large capacities to lift large volumes of water from the canals to their fields in a short time, hence disadvantaging those with small pumps. It should be noted that the irrigation law stipulates that farmer pumps should be licensed by the irrigation agency to guarantee fair water distribution among the farmers.
- Water theft: some farmers block the outlets of others over night to divert all the water to their fields.
- Incompatible crops in adjacent fields: the typical case is when rice and cotton are grown in two adjacent fields. Rice cultivations usually raise the shallow water table which adversely impacts nearby cotton cultivations.
- Money collection for canal cleaning and maintenance: farmers sometimes refuse to contribute to the maintenance of the tertiary canals either by carrying out some of the work or by paying their share of the cost.

The mechanisms used for resolving water conflicts include: 1) complaining to the irrigation engineer in charge of the system, 2) sending written complaints to the top authorities either within MWRI or in the Government, 3) getting the local leaders in the community involved, 4) resorting to the BCWUAs, and 5) complaining to the agricultural cooperatives. In this respect, it is clear that farmers use all the mechanisms available for conflict resolution. Prior to the establishment of BCWUAs in the area, farmers preferred to resolve the conflicts through the local leaders in the community especially for the conflicts which arose among themselves. Complaining to the authorities through the irrigation engineer or the higher authorities in MWRI is mainly used in the case of absolute shortage of irrigation water supply in the canals. The introduction of BCWUAs in the area provided a new mechanism for conflict resolution. This case study shows that the role of BCWUAs in resolving water conflicts has been increasing from 2001 to 2005.

The impact of certain factors, such as farm size; farm location; farmer education; gender; and degree of water user participation in BCWUA activities, on the selection of the conflict resolution mechanism was investigated. The analysis showed that both the farm size and the degree of water user participation in BCWUA activities are not important factors in determining the conflict resolution mechanism to be used. On the other hand, the farm location, farmer education and gender are important factors in selecting the conflict resolution mechanisms. Farmers at the head of the irrigation system prefer to resort to the irrigation engineer, the BCWUAs, or the agricultural cooperatives; while those at the tail prefer the informal mechanisms through neighbours and community leaders. Water users with some degree of education are more aware of BCWUAs activities and hence get them involved in conflict resolution, whereas illiterate farmers prefer the informal mechanisms. On the gender issue, women tend to mainly use their neighbours and community leaders for conflict resolution. Rural customs and traditions that still prevail in many parts of the country and regarding irrigation as a men-dominated activity are perhaps the main reasons behind such a behaviour.

4.1.7 Case Study 5: New Lands Systems

In the 1950's, and in an attempt to expand its agricultural land horizontally, Egypt embarked on a massive desert land reclamation project at the north west of the Delta of Mudiriat Al-Tahrir. More recently, these efforts moved westward reclaiming new areas[2].
The area of Sugar Beet (Bangar El-Sukar) in Alexandria Governorate, with its 45,000 feddans is one such area, from which a village was taken as a case study. The village of 1200 feddans was established 20 years ago and is now the home for 200 families (6 feddans per family), mostly young university graduates coming from the governorates of Behaira and Alexandria.

This village has therefore some main differences in its social structure from the previous case studies: most of the water users are young people of high education, they lack the agricultural experience, a high percentage of the land owners (46.5%) are females, and kinship ties are not a main element of the social structure because inter-village marriage is yet to take place or constitute a phenomenon.

The irrigation system in the village is also different. The village gets its water from Al-Nubaria canal through Al-Nasr canal. Because the latter runs uphill, five main pumping stations are distributed along the canal every several kilometers. The village is located at the tail-end of Al-Nasr canal thus takes water from the reach downstream from the last main pumping station. Two branch canals (no. 6 & 7) offtake from Al-Nasr to irrigate the village lands through some tertiary canals. All the canals are concrete lined and their water levels command the land so irrigation is fully by gravity (farmers do not have to do any water lifting). However, about 15 farmers have their own mobile diesel pumps, which they use themselves and hire out to others. The pumps are used as a back up whenever the need arises such as when the water level in Al-Nasr canal is low or for supplementary irrigation from the drains in case of absolute canal water shortage.

Agriculture in the village is not basically for subsistence but is more market oriented. The main summer crops are water melons, tomatoes, maize and vegetables. In the winter they are dominated by wheat, berseem and

[2] Those new areas are generally referred to as the "New Land" in Egypt.

vegetables. Most of these crops are not high water demanding, which highlights water scarcity in the area. There is also a high degree of mechanization of the agricultural activities, thus there is no high demand for labour and most manual activities are done by family members. The majority of the farmers raise cattle and sell milk in the market to provide cash flow.

In theory, Al-Nasr canal should operate under rotational schedule of 7 days on and 7 days off. In reality, the farmers say that it is sometimes 7 days on and may be 30 to 40 days without water, especially during the months of June and July. Farmers sometimes have to jump out of bed during the night when they know that water has arrived. They compensate the severe canal water shortage by irrigating from the drains using mobile diesel pumps. The pumps are rented out for LE 7 per hour, thus irrigating one's entire land of 6 feddans costs some LE 126 to 168 as it takes about 3 to 4 hours to irrigate one feddan. If farmers have to do that two or three times during the summer season, then canal water shortage costs them between LE 250 to 500 per year. Some farmers have tried to dig wells, but groundwater quality proved saline and not appropriate for irrigation.

Farmers in the village stated that Al-Nasr canal is operating at its full capacity and there should be enough water for everyone. Water shortage in the village is attributed to the following reasons: 1) the village is located at the tail-end of Al-Nasr canal whereas big investors, each of whom owns 3000 feddans, are located at the head and middle reaches of the canal who have the power to influence the rotation system; 2) water is stolen by other upstream farmers who pump directly from Al-Nasr canal; 3) the use of surface irrigation methods in lands that are designated for modern irrigation methods (sprinkler and drip); and 4) illegal cultivation of rice in the command areas of pumping stations 2 and 3.

Furthermore, farmers on the same tertiary canal can irrigate at any time water is available in the canal. This usually adds to the water shortage problem due to fierce competition on water. In 1999, the area saw the first trial to organise irrigation by the establishment of Water Boards (WB). A WB is defined as a user-managed water management organization, responsible for both irrigation and drainage as well as water quality in a specific command area. The WB is assumed to organize irrigation turns among the farmers, settle disputes and handle irrigation violations. However, WBs still lack the legal status as they are not recognised by any law yet. As a result, the ability of WBs to enforce decisions; apply sanctions on their members; generate and allocate resources; and demand an improvement in the services from the irrigation and drainage authorities; have been undermined. Consequently, most irrigation disputes are resolved informally by a customary council which may include members of the WB or not, in addition to other well reputed members of the community.

Although farmers stressed that irrigation violations were rare occurrences in general, irrigation disputes in the village are of more violent nature when compared to the other case studies. They do not stop at the exchange of harsh words or cursing, but go far beyond to physical attacks, beating, and even some killing. This can be attributed to the absence of kinship ties between the households which certainly play an important role in controlling conflicts and to the strong competition for water due to canal water shortage.

4.1.8 Case Study 6: Water Distribution Mechanisms in the Oases

The oases in the Western Desert represent a rather different case from the previous ones. In the Desert, groundwater is the main water resource and it is mainly non-renewable. People typically settle down around springs and boreholes. They appreciate the value of water and its important role in their lives. Water is considered the source of economic activity and power not the land.

The main and original inhabitants of the oases are tribes who emigrated from the Arabian Peninsula long time ago. Recently, the oases started to attract more people from the nearby cities of the Nile Valley and Delta. The structure of the population has therefore changed with time. However, the oases still hold their unique social and cultural characteristics. Tribal values and rules are very important factors that determine the behaviour of the people in the oases. The heads of the tribes and families have always been respected because of the homogeneity of the population.

The natives have developed their own framework to regulate groundwater development and use. The framework consists of various steps that are followed when a new water point is developed; namely agreement, implementation, development, and follow up and evaluation. Prior to any decision on drilling a new water point, a "board" comprising the heads of concerned families (beneficiaries) meet to discuss all actions including the selection of water point location; distribution of water shares, roles and cost (money, effort, animals or crops); selection of labour; election/selection of a chair person for the water point (who is normally the one holding the largest share and/or has high experience in the work) and preparation of the initial contract, containing all the agreed upon items from which a copy is given to each family head/representative. Work implementation and water point development are carried out under the supervision of the chair person. After completing the development of the new water point, the board meets again to assess the actual flow and hence distribute the water and land shares (land is distributed longitudinally, taking into consideration equity in land quality, the water flow and topography); agree on allocation of a portion of the flow to the guard who is also responsible for the maintenance of the distribution system; and prepare the final version of the contract. Water and land shares are allocated to the family heads only, who are responsible for the internal distribution among family members. Water shares are based on time shares. The sum of all time shares is adjusted such that water is diverted to each shareholder once every seven days in the summer and every 12 days in the winter. Each shareholder is obliged to start by planting wind breaks to protect the land from moving sands and sand dunes. The board meets periodically to revise the water allocations and shares (if needed); plan the next cropping pattern of non-perennial crops; follow-up all work activities, including maintenance and plantation of wind breaks; solve any conflicts among the beneficiaries; and collect taxes (money or products).

Although soils in the oases are relatively light-textured, surface irrigation methods are largely used resulting in low water use efficiencies at the field level. However, water management incorporates many features that help preserve the resource and raise the overall water use efficiency such as:

- Irrigation is practised seven days a week, 24 hours a day to match the nature of groundwater flow (continuous) and to eliminate wastage. Otherwise, storage reservoirs are constructed for night or accidental storage.
- Irrigation canals are lined with heavy clay to minimise seepage losses.
- Additional water gifts are given to those who irrigate during holidays to encourage people to use the water during those occasions.

  In such a water-scarce environment, conflicts over the vital and precious resource are inevitable unless strong measures are taken to prevent or minimise them. Such measures in the oases system include:

- Informal user organisations: The water point chair person and board constitute an informal water user organisation that organises and oversees water allocation and distribution. The social status of those people among the rest of the community helps them carry out this task efficiently. More over, the whole community participates in decision-making as they are consulted by the leaders before final decisions are taken.

- Water distribution is based on a transparent and fair system:
  - Additional water gifts are given to tail-enders to compensate them for seepage losses from the canals.
  - Additional water gifts are given to those who irrigate during windy conditions to compensate them for the reductions in the flow due to wind drift.
  - Any shortage in the supply is equitably divided among all users.

- Demand management: The cropping pattern is planned by the water point board before each growing season to adjust the demands to supply.

4.2 Iran

Iran is located in a semi-dry region and is characterized by an uneven rainfall in terms of quantity, timing and location. The average annual rainfall is 250 mm. About 70% of the rainfall in Iran occurs over 25% of the country's total surface area while the remaining 30% occurs over the remaining 75% of the surface area. This results in high variability in the water resources in the different regions of the country. Historical data also shows that the country usually experiences seven-year cycles of dry and wet periods.

Agriculture is a vital sector in Iran's economy. It now accounts for 27% of GNP, 23% of employment, and more than 85% of water consumption. Surface irrigation methods are practised in almost all irrigated areas. Application efficiencies are very low at 30% giving high potential for water savings through more sustainable use of water in agriculture.

4.2.1 Sources of Water Conflicts

Since agriculture is the main water user in Iran, most conflicts and challenges pertinent to the use of water resources relate to this sector. The main sources of such conflicts are outlined below, followed by case studies which further demonstrate some of the problems.

- Disputes over water distribution: Such cases are applicable to irrigation areas which feed from surface water sources. Usually, water is distributed among the beneficiary farmers according to their well-defined water shares. However, the shareholders sometimes dispute the way water was actually distributed claiming that it did not satisfy their shares properly.

- Unequal distribution of water shortages: Due to cyclic changes in the climate, Iran often faces some dry periods every now and then. During those dry periods, the yield of most water sources is affected and decreases every year. The beneficiaries at the head of the source still take their full shares of water and continue to use the water irrationally, leaving very little or hardly any to the tail users. Yet, this behaviour of the head users is not illegal which does not restrain them from doing so and prevents the tail users from taking them to court. Faced with severe water shortages that threaten their livelihood, the tail users take matters into their hands and fight with the head users over the water. The consequences are clear.

- Unauthorised use of groundwater: The use of groundwater has been recently regulated. The regulations impose restrictions on existing legal well owners and on the drilling of new wells with the main objective being to ensure the sustainability of the resource. The restrictions on existing legal well owners include well-operation schedules which define the maximum numbers of daily operation hours and operation days per year. Restrictions on new wells require that permits be obtained from the authorities before the wells are drilled. However, these restrictions are widely violated: existing well owners do not stick to the operation schedules to pump more water and new wells are drilled without permits. As a result, groundwater tables are rapidly declining risking the sustainability of the resource and rendering many wells non-productive. Conflicts between the affected well owners and the violators are inevitable.

- Despite of the nationalization of water in 1967, which gave the State the full control over the water resources, individual water rights remained the same. Different interpretations to the "water rights" existed, some of which meant that water was subject to the laws of inheritance. Accordingly, both land and water shares became fragmented among the younger generations who inherited them from their dead fathers. Landholdings became too small to generate an income that is enough to sustain the owners' families. The cost of maintaining the canal network or communal wells added to the burden on the farmers. Many of the farmers could not afford to pay their shares of the maintenance costs leading to disputes and conflicts.

4.2.2 Conflict Resolution Mechanisms

Different conflict resolution mechanisms existed throughout the long history of Iran. In the past, any dispute or conflict was solved based upon "urf" or customary rules and regulations. In doing so, elders,

community and religious leaders, and informal water user organisations played very important roles. Moreover, all arrangements concerning agriculture and irrigation were in place for centuries and honouring them was regarded as everyone's responsibility. After the land reform in the 1960s, the traditional arrangements and institutions died out, and any dispute and conflict should be settled legally in court. However, civil codes are mainly urban oriented and seldom specific laws and regulations have been ratified to be in harmony with the rural life and peculiarities of agricultural undertakings. In addition, the legal process is usually time-consuming whereas many water-related conflicts are so urgent that they must be resolved quickly before they escalate. Finally, according to civil codes jail sentences are possible for violators; something that can hardly be enforced in rural communities where in majority of cases the disputing parties are relatives with some kinship ties. Under such circumstances it is almost impossible to enforce the law. Consequently, today rural communities try their best to solve conflicts internally by making the elders and community and religious leaders intervene. It can be said, therefore, that apart from the constant weakening of custom-based practices, no conflict management mechanisms exists in Iran at present.

A new arrangement has also emerged that is relevant to the cases which involve conflicts over money payments. When one, two or even three shareholders or co-owners refuse to pay their money shares, say for maintenance, the other shareholders pay those sums of money hoping to collect them later from those who are in debt. Nonetheless, such disputes are forcing farmers to look for individual solutions (e.g. dig their own wells).

4.2.3 Case Study 1: Ghanat Irrigation Organisations

Different types of informal water user organisations existed in Iran a long time ago. Those organisations operated at the local level for managing and distributing available water resources among the shareholders. The type of organisation depended mainly on the main water source, the most common of which was the irrigation organisations of the aqueducts (ghanats). This type of organisation consisted of a head, a water boss, a well driller and a watchman. The head, who was usually the person with the largest land and water shares, supervised the activities of the other members, determined their work loads and fees, and settled disputes and conflicts among the shareholders. The water boss supervised water distribution among the shareholders and hence had to be an experienced, trustworthy and honest person. The other members of the organisation helped the water boss in distributing the water jointly with the shareholders themselves.

Water distribution was based on time shares. The day was divided into three eight-hour intervals: morning, afternoon and evening. Farmers whose farms lie next to each other and have combined water rights equal to eight hours could irrigate their lands one after the other. Under the supervision of the watchman, the farmer who irrigated opened the water way to his land while the others tightly closed their water ways until he finished, and so on. The water boss sat at the head of distribution network and measured each farmer's water allocation to make sure that it matched his share. This was usually done in the presence of one of the shareholders or one of the community leaders.

Theoretically, this system was prone to conflicts which could have arisen for reasons such as whether the water boss measured water allocations properly or not or whether the farmers who were supposed not to irrigate tightly closed their water ways or not, etc. In practice, those informal organisations proved very successful means of managing the irrigation process and preventing conflicts among the shareholders. The reasons behind this were: (1) the members of the organisations were trusted persons in the community and were selected/elected by the shareholders, (2) the water distribution process was transparent to every shareholder who knew each others shares, and (3) the social ties in the community were so strong that no one would dare to jeopardise them by committing any wrong act.

4.2.4 Case Study 2: Khordad Dam and Downstream Farmers

In 1996 when the 15th of Khordad Dam was completed and became operational, it deprived many downstream farmers, who had water rights, of irrigation water. Angry, they stormed the Governor's Office in Ghom City together with land tenants and those who had cultivation

rights and altogether occupied the building for hours. The government thus faced a critical situation which could have easily become a major national event with far reaching consequences. Subsequently, the Governor immediately ordered the Department of Jihad for Agriculture to provide the farmers with appropriate pumps and pipes to enable them to abstract water from the reservoir of the Dam to irrigate their lands. In addition, he ordered that some water should be released from the Dam into the channels previously used to irrigate the lands before the Dam was constructed. However, although these actions solved the farmers' problems, it caused water shortage in the city of Ghom for which the Dam was constructed in the first place.

4.2.5 Case Study 3: Groundwater Resources Abstraction

There are 600 plains in Iran which are considered the backbone of the country's agriculture. Because groundwater was usually not so deep in those plains (not more than 50 m), well water was used for irrigation. Animal power was used in some wells to lift the water. After water nationalization, well drilling was regulated in order to prevent over abstraction of groundwater and stop the rapid decline in the water tables. Authorities issued permits for new well drilling provided that the total well abstraction capacity did not exceed 85% of the natural groundwater recharge.

Nonetheless, illegal well drilling continued threatening the sustainability of groundwater resources in the plains. In addition, illegal well drilling and the eight-year severe drought of 1995 to 2002 made legal well owners violate the well-operation schedules defined by the Ministry of Energy and operate their wells for longer hours to pump more water. For example, a legal well might be allowed to pump water through 5-inch pipes for up to 6 hours a day for a total of 200 days a year; instead, the well owner uses more powerful pumps with 8-inch pipes and pumps water for 8 hours daily and for a total of 300 days a year. The combined effect of illegal wells and illegal abstractions led to drastic decline in groundwater levels. Today, 450 plains out of the 600 are in very critical conditions. In more than 100 water beds, water levels have dropped 50 meters drying up the wells at high grounds.

For three decades, legal well owners not only tolerated illegal well drilling activities because of ethnic and family ties, but also provided assistance in any way they could to the violators! Nowadays, they no longer tolerate such illegal acts and this has led to widespread conflicts among families thereby threatening the social cohesion within Iran's rural communities. The use of groundwater for irrigation has become the most critical issue in the country and is continuously the cause of deep conflicts which, at times, eventually end up in bloody fights.

4.2.6 Case Study 4: Regional Water Transfers

The water resources in Iran are not uniformly distributed across the country. A large percentage of the internal water resources is generated in the northern strip bordering the Caspian Sea and in the south of the Zagros mountain range. Large areas of the country therefore lack sufficient water resources but at the same time have good agricultural land. This situation requires the transfer of water from one region to another. At present, water is transferred from the branches feeding the Karoon River to the Zaiandeh Rud through the Kohrang tunnel to irrigate the plains of Isfahan. Likewise, some water from the Shahrud River in Taleghan is transferred to the Ghazvin Plains while water from Gavrud in Kurdestan is transferred to the agricultural lands of Kermanshah. These have been the major completed undertakings in water transfer in Iran.

Studies are underway for the transfer of water from Dez River in Lorestan Province to Golpaygan and Ghom to be used for drinking, particularly for the cities of Ghom and Kashan; and from Zohreh River in Kohkiloieh and Boier Ahmadi to Bushehr Province for the irrigation of dry farming lands in the Liraby area.

However, these water transfer projects have been the subject of heated debates. Typically, the areas from which water is to be taken refuse such projects claiming that they need the water themselves. In reality those claims have no true basis, but are stimulated by political groups and the endeavours of local elements to gain more votes in the local elections. The most notable of such debates is the objection by the parliament members representing Khouzestan Province to the transfer of 180 million cubic meters of water from Karoon River to the thirsty plains of Sirjan, a main-producing area of Iran's pistachios. It is worth noting that the quantity of water planned for transfer represents just 1.6% of the 11 billion cubic meters annual flow of Karoon River. In fact, if just 1% of the water resources in Khouzestan is conserved and if water consumption in the Province is rationalised, it will be easy to save one billion cubic meters of water in Khouzestan for the dry central plains. The Ministry of Energy is also responsible for the outbreak of those debates by not educating the general public about the objectives of those projects and their importance to the whole country.

4.3 Jordan

Jordan is one of the Arab countries that is located to the north of the Arabian Peninsula and to the east of the Mediterranean Sea. The country can be divided into three distinct regions from west to east: the Jordan Rift Valley (JRV), the Plateau and the semi-desert or the "Badia" region. The JRV runs from Lake Taberia in the North to the Gulf of Aqaba to the south with elevations of less than 300 m above mean sea level. The plateau is a narrow strip running to the east of JRV with elevations between 300 m to above 1200 m. Rainfed agriculture is practised on the arable lands of the plateau with average annual precipitation of more than 300 mm. The remaining part of Jordan (about 90% of the country) is semi desert locally called the "Badia" region. The population of Jordan was 5.35 million in 2004.

The total land area of Jordan is about 88,778 km2. Only 4% of this area can be put into cultivation through rainfed agriculture in years of sufficient rainfall. Areas developed for irrigated agriculture amount to approximately 72,000 ha. Of this total, 33,000 ha are in the Jordan Valley and the southern Ghors which are primarily developed by the Government. The rest of the irrigated area of about 39,000 ha has been developed by the private sector in the Plateau and the Badia regions depending mainly on groundwater.

Water resources consist of surface and ground water, with reclaimed wastewater being used at an increasing scale for irrigation. Annual renewable water resources vary from 785 to 840 MCM, including 280 MCM of groundwater and 505 to 560 MCM of potentially exploitable surface water. An additional amount of 143 MCM is estimated to be available from the non-renewable groundwater aquifers. The volume of effluent from the different wastewater treatment plants was estimated to range from 75 to 80 MCM in 2004. Water desalination has also become an optional source where 40 MCM are presently produced from over 10 desalination plants for domestic supply and about 9 MCM for irrigation.

However, surface water resources have been significantly affected by urbanization and upstream uses in the catchment areas as well as climatic changes. On the other hand, groundwater over-abstraction is evident in many aquifers where the safe yields have been exceeded by more than 100 percent in some cases. As a result, rapid declines in the water tables and well salinisation are witnessed.

The general policy of the government give priority in water allocation to the municipal uses followed by industry and what is left is allocated to agriculture. At present, shortages of fresh irrigation water are being resolved by over-extraction of groundwater in the high lands and in the desert and the rationing of irrigation water use in the Jordan Valley. The problem is further alleviated by diverting the reclaimed wastewater to irrigate some parts in the central Jordan Valley. However, if this continues the agricultural sector will suffer the most and thus the increase in irrigated area will be limited. No foreseen solution to this problem but to relay on reclaimed water as an additional source.

4.3.1 Sources of Water Conflicts

Water conflicts in Jordan revolve around a diverse set of issues, including decisions on surface and ground water allocation and water quality matters that include effluent standards, drinking water treatment, and in-stream habitat needs. Port development, hydropower projects, flood control and wetland protection can all generate controversy. Water conflicts are concentrated in the following issues:

1. Conflicts due to the water allocation policy to user sectors.
2. Conflicts due to the control of groundwater over -exploitation.
3. Conflicts over water tariffs for different sectors.

4.3.2 Conflict Resolution Mechanisms

Most of the water conflicts in Jordan are between the State and the water users; no serious conflicts among

the water users themselves are reported. Most surface irrigation projects are publicly owned and water delivery and rights are controlled by the State. The main disputes are related to water allocation and law enforcement. Serious conflicts arose when the government tried to enforce the law on resource tax of water. The issue was resolved between the Ministry of Water and Irrigation and the farmers represented by the Jordan Farmers' Association. Both parties had to seek the assistance of mediators from parliament members and water experts as well as the press and the media. Because water in Jordan is a public issue; NGOs, public institutions and the media also play an important role is resolving related conflicts and disputes.

The water conflicts associated with water rights are limited to few areas that are irrigated by the base flows of secondary rivers or springs. Generally, no serious conflicts have been reported during the last two to three decades. All matters concerning rotation and flow rate are established within the users. In rare cases, the conflicts have reached the court.

In 1997, a National Water Strategy was approved by the government. The strategy defines the long-term goals that the government of Jordan seeks to achieve in the water sector in terms of improved water resources management with particular emphasis on the sustainability of present and future uses. Part of this strategy was an institutional reform which brought the three public agencies responsible for the management of water resources in Jordan (the Ministry of Water and irrigation, MWI; the Water Authority of Jordan, WAJ; and the Jordan Valley Authority, JVA) under the umbrella of MWI. This helped solve the problems of fragmented short-term policies and overlapping responsibilities between the three agencies (MWI, WAJ and JVA) that existed before the reform.

MWI is seeking to achieve the goals of the Strategy through the formulation of certain policies. Currently, the following four policies have been prepared and published:

1. Groundwater management policy which addresses the management of ground water resources including development, protection, management, and gradual reduction of abstraction rates from renewable aquifers to the safe yields by 2010.
2. Irrigation policy which addresses irrigation water including agricultural use, resource management, technology transfer, water quality, and efficiency, but does not address or extend to irrigated agriculture. The policy also introduced a new water tariffing structure that aimed at recovering the operation and maintenance costs and as possible the capital cost. It was also to be used as an incentive to improve on-farm irrigation efficiency.
3. Wastewater management policy which addresses the management of wastewaters as a water resource including development, management, collection and treatment, reuse, and standards and regulations.
4. Water utility policy which covers issues such as institutional development; private water participation; water pricing and cost recovery; human resources development; water resources management; service level; water quality and the environment; public awareness; conservation and efficiency measures and investment.

4.3.3 Case Study 1: Domestic and Irrigation Demands in the Jordan Valley

The Jordan Valley Irrigation Project is a public project managed by the Jordan Valley Authority (JVA). Irrigation water to this project comprises the flows of the Yarmouk River and other small rivers and wadis. Due to the political situation in the area and Israeli control over the flows of the Jordan River, existing surface water is not sufficient to irrigate the arable land in the Jordan Valley. Out of about 29,000 ha equipped with irrigation systems, water rights are given to 23,000 ha only. The remaining 6,000 ha are irrigated by excess flow during the winter in good rainy years. In spite of this water shortage in the Valley, about 50 to 60 MCM of fresh water are pumped annually from the King Abdullah main canal to the Greater Amman Area for domestic purposes. About 80% of the population in Jordan is concentrated in the urban areas in the governorates of Amman, Zarqa and Irbid, all of which are water-deficit areas and depend on water importation from other areas. The agricultural sector in the Valley is compensated with reclaimed wastewater, which is

typically not of the same good quality as the taken fresh water. In addition, the agricultural sector in the high lands is asked to reduce its pumping rate to the safe yield level. These practices have made farmers lobby through their farmer associations demanding sustainable agriculture while ignoring the element of safe yield or the right of future generations. Their argument is against shifting groundwater from agriculture to urban uses. Enforcement of the law will contribute a great deal to the conflict resolution.

4.3.4 Case Study 2: Irrigation Water Quality in the Jordan Valley

To overcome fresh water shortage for irrigation purposes in the Jordan Valley, the effluents of four wastewater treatment plants located in the Zarqa Basin are mixed with the flow of Zarqa River and stored in the King Talal Reservoir. The release of this reservoir is used to irrigate the central Jordan valley. In dry years when the yield of Zarqa Basin is very low, the mixture of effluent and fresh water in the reservoir is of low quality with salinity levels reaching 1500 ppm. This issue has raised the concerns of many farmers in the central Jordan Valley. In the year 1989/1990, the deterioration in the water quality reached a critical level. Many farmers witnessed crop failures and claimed that low water quality was to be blamed. The JVA investigated the issue thoroughly by asking a third party to determine the causes of crop failures. The independent committee concluded that the crop failures were due to unusual weather conditions associated with drought that had resulted in spread of insects and diseases. Some farmers were not convinced by this conclusion and had appealed to the court asking for full compensation for their failed crops. The case was dismissed due to lack of evidence.

On the other hand, the Ministry of Water and Irrigation has commissioned a study under the activity of the FORWARD project to investigate the low irrigation water quality problem in the central Jordan Valley. The study recommended that water tariffs be based on water quality.

4.3.5 Case Study 3: Groundwater Utilisation and Tariffing

In order to have control over the use of groundwater, the Government of Jordan has taken regulatory measures including limits on new well licences, progressive installation of meters on all wells so that abstractions could be monitored, permit conditions enforced and further restricted. Financial control has been applied through the introduction of a resource tax, a volumetric charge on water abstractions. These controls have been institutionalized in the By-Law 85 of 2002 "Groundwater Control By-Law". The most import provision in this By-Law is the reiteration that the groundwater is owned and controlled by the State. Any act regarding extraction or utilization is prohibited except by a licence. Ownership of the land does not include ownership of the groundwater. The law explains the regulating measures in drilling and extraction licences for different situations. It also explains measures and regulations to protect the groundwater from pollution and depletion. Technical issues such as the safe distance between wells are also included.

It is clear that the enforcement of some provisions of this low regarding reducing the pumping rates and water tariffing will face great difficulties. It is claimed that agriculture uses 54% of the groundwater abstractions or about 250 MCM/year excluding the fossil water of Disi. The reduction of about 160 MCM will be from the agriculture share leaving it to 90 MCM only. This will be gradually implemented over a period of 10 years. This will result in disputes and conflicts between the State and the farmers through their associations.

In implementing the tariffing provision of the law, the government was faced with objections and protest from the water users. A key player in the opposition was the consortium of companies who are exploiting the non-renewable groundwater of Disi and Mudawarah aquifers. The consortium and the Jordanian Farmer's Association as one party were against the law in the tariffing aspects. They used different means to lobby their position including petition to the King and Prime Minister, putting large advertisements in the newspapers and drawing the public opinion. They have reduced and addressed some parliament members to be on their side. This was in parallel with negotiations with the Ministry of Water and Irrigation. After few months of disputes and negotiations with the government, they reached an agreement to increase the allowed pumping limit and reduce the water tariff.

4.3.6 Case Study 4: Change of Irrigated Crops and Water Use

Water allocation within the agricultural sector depends on the cropping pattern. The general policy of JVA is to allow for a free cropping pattern with the exception that the area of fruit trees should not exceed 30% of the irrigated area. In addition, planting fruit trees should be based on permits from JVA. These provisions are taken in order to guarantee the water rights and allocations for permanent crops during the summer season. Nonetheless, some farmers violate these regulations by planting fruit trees exceeding the maximum limit or in areas that does not have the right to water. In such cases, JVA responds by stopping water delivery to those farmers. The farmers then go to court demanding immediate action to save their trees. The court usually issues an order asking JVA to deliver water to those farms until the case is foreseen. This process might take 2 to 3 years.

In an effort to achieve food security and self reliance, the government decided to increase the production of wheat and livestock. In doing so, about 6000 hectares of land in the southern desert were leased to six private companies which were issued groundwater abstraction licences. The aim was to utilise the fresh groundwater to produce wheat and fodder crops. After few years of cultivation of wheat and fodder crops the companies shifted to the cultivation of fruit trees and vegetables. By doing so, they would be violating the leases that were granted to them. The issue is pending waiting the final decision on pumping the Disi waters to urban uses in the central part of the country.

4.3.7 Case Study 5: Restoration of Wetland and Biodiversity

Significant damage to water resources and dependent ecosystem in Azraq basin has occurred due to heavy abstraction of groundwater to irrigation uses and drinking supplies for Amman and Zerqa. For almost 10 years, the rate of pumping has exceeded 50 MCM in comparison to the safe yield of about 24 MCM. The result of that was rapid lowering of the water table, deterioration of water quality and drying-up of natural oases. The oases and the created wetlands around them were a heaven for migrating birds and plant and animal biodiversity. These wetlands are now almost dry resulting in disruption to the ecosystem. With the support of local NGOs, the United Nations through RAMSAR convention has declared Azraq wetland of international importance. A project was funded by GEF to restore the wetland. After negotiations between project staff and the NGOs on one side and the Ministry of Water and Irrigation on the other side, an agreement was reached to discharge 1.5 MCM per year of groundwater to the wetlands in order to restore them. After 10 years of pumping, 20% of the wetland has been restored.

4.3.8 Case Study 6: Environmental Damages due to Groundwater Overpumping

Over-pumping from the upper basins of Yarmouk and Zarqa has seriously affected the base flows of these two rivers. The base flow of Yarmouk has dropped from about 6 m3/s in the 1960s and 1970s to less than 3 m3/s in the late 1990s. Also many springs along the Zarqa River have dried up completely reducing the base flow from 3 to 4 m3/s to less than 1 m3/s. These situations have resulted in serious environmental problems affecting the fauna and flora of the two rivers. No short- or long-term measures have been taken to address these problems. These cases can be considered as conflict cases between the State and the environment.

4.4 Morocco

Morocco is located in the northwestern corner of the African continent extending over an area of 710,850 square kilometers. Morocco's relative high altitude distinguishes it from the neighbouring countries. The Atlas mountain chains cross the country from south-west to north-east reaching altitudes of 4000 m. The plateaus occupy the major part of the territory and are located at variable altitudes close to the Atlantic littoral, to the west of the Middle and High Atlas chains and to the east of the country. The plains extend on vast areas of the territory: along the Atlantic littoral, along the Mediterranean littoral, inlands, and to the east of the country.

The population in Morocco is estimated to slightly exceed 30 millions, of which more than 58% is urban and 42% is rural.

The climate varies between the humid Mediterranean climate in the north to the Saharan desert climate in the south with a gradual reduction in rainfall in between.

The mountainous areas profit from a sub-humid to wet climate with annual rainfall exceeding 1000 mm.

Average renewable water resources are estimated at 20 km3/year, out of which 16 km3/year are surface and 4.0 km3/year are groundwater that can be exploited at acceptable economic conditions. Currently, only two-thirds of this water is used, with agriculture accounting for 83% of total water use as summarised in .

Water resources management in Morocco faces several challenges:

- Droughts: the country frequently experiences periods of prolonged droughts as witnessed during the last two decades. Annual water resources in dry years can be as low as 30% of those in average years, reflecting the serious impacts those droughts can have. In response, a large number of dams of a total storage capacity of 15 million m3 has been built to secure the water demands of the country.
- Floods: on the contrary to the severe droughts, serious floods cause considerable damage to the infrastructure and losses to the economy. The serious impacts of the floods can be attributed to the improper design an insufficiency of flood protection works, poor planning of land use and the continuous reduction to the capacity of the watercourses due to the heavy sedimentation left over after floods.
- Siltation of storage reservoirs: the total storage capacity of the large number of dams in Morocco is rapidly decreasing as an effect of siltation in their reservoirs. About 5% of the storage capacity is lost annually, i.e. approximately 65 million m3, or the equivalent of a storage capacity of one dam. The rapid siltation is associated with the poor population who live in the mountainous catchment areas and subsist on activities which create favourable conditions of erosion in the catchments.
- Groundwater mining: overexploitation of groundwater resources, especially by the agriculture sector, and the severe droughts are having negative impacts on the resource leading to continuous reductions in the reserves, drying-up of wells, and deterioration in the water quality by seawater intrusion.
- Pollution: the quality of all water resources is threatened by pollution from the untreated agricultural, domestic and industrial wastes. Nearly 180 million m3 of urban wastewater are currently drained in the rivers without sufficient treatment. The quantity of industrial wastewater discharged in the rivers is estimated as equivalent to the quantity generated by 3.3 million people. The annual production of domestic and industrial solid waste is evaluated at approximately 4.7 million tons, the majority of which is dumped in areas at the edges of existing irrigation schemes. As a result, alarmingly-high nitrate contents are found in the groundwater resources underlying those irrigation schemes.

Table 2: Summary of annual water resources in Morocco (km^3)

	Surface water	Groundwater	Total
Potential:	16.0	4.0	20.0
Water use:			
• Agriculture	9.17	2.0	11.17
• Drinking & industry	1.58	0.7	2.28
• Total use	10.75	2.7	13.45

4.4.1 Sources of Water Conflicts

Water conflicts in Morocco are of several natures and can occur between individuals, groups of people, and institutions. The main sources of conflicts can be summarised as follows:

- Water sharing/distribution: this is perhaps the most common source of disputes and conflicts that can occur between different groups of people who share the use of the same surface or groundwater resource. Typically, competition between upstream and downstream users increases as water becomes scarcer. Conflicts can also be between groups of people and the elected officials who privilege those who voted for them. Similarly, conflicts can be between groups of people and administration in charge of water management over water allocation and distribution.

- Undefined boundaries of public water bodies: Law 10/1995 declared all water resources and water bodies as public domain. However, the exact boundaries of many of the water bodies are not clearly defined. Conflicts therefore occur when people start any development in some of those areas only to be confronted with the fact that they have encroached on some water bodies and are therefore required to relocate their investment.

- Bureaucracy: acquiring new permissions to extract water or to exploit water resources is seriously hindered by long bureaucratic procedures that may drive people to illegally start using water without getting the necessary permissions.

- Flood damages: the damages caused by floods are usually the cause for accusations between the affected people and the authorities. The affected people accuse the authorities of not taking due action to warn them about the floods and to protect their properties by installing flood protection works. In the mean while, the authorities accuse the people of badly siting their properties in flood paths.

- Pollution: as described earlier, pollution threatens most of the water resources in the country. Conflicts arise between the polluters and the users of the polluted water.

- Development of new water works: the development of new water works, especially dams, usually bring about disputes and conflicts. It is mandatory for such new large-scale projects to have environmental impact assessments carried out during the planning phases. The environmental impact assessments may render the projects infeasible or may assess, among other possible impacts, the number of people affected. In the case of dams, people may have to be relocated to new areas as their home lands are to be used for dam reservoirs. Often, those people neither accept to be relocated nor accept the compensations given to them by the government.

- Water charges: Law 10/1995 introduced water charges through the principles of “extractor pays” and “polluter pays”. However, people sometimes argue that water charges are against Islamic principles that prohibit water trading. Those people are continuously reminded that it is the service that they are paying for not the water itself. Farmers also claim that water charges represent a high percentage of agricultural inputs and try to delay the payments. As a consequence, the rates of water charges collection are low in many areas. In addition, drinking water tariffs must be carefully determined in order not to exceed the capacity of the poor population; otherwise they will ask for their right to water and may express their dissatisfaction in violent ways.

- Investment planning: investment planning in the water sector is one of the principal sources of conflicts which arise at various decision levels. The conflicts are related to the diversity of the institutions involved in the planning process and the ministries involved in the implementation process.

4.4.2 Conflict Resolution Mechanisms

Conflict resolution mechanisms in Morocco exist at various levels of the institutional system. Each conflict is dealt with in the appropriate level according to its complexity and the parties involved. The lowest level of conflict resolution, the local level, deals with problems related to water sharing, the recognition of water rights, flood damage, or water pollution. A commission comprising local authorities, ministries, and public organisations makes its decisions on the basis of studies prepared by the involved Basin Agencies. If the commission fails to resolve a conflict, it is raised to the Ministry of Land Planning, Water and Environment. Interdepartmental commissions within the Ministry resolve conflicts between the departments. When the conflicts have a national dimension, and the interdepartmental commissions are not able to find consensual solutions, the Interministerial Commission is consulted. It is chaired by the Prime Minister and includes representatives of all the ministries concerned with the water sector as well as the Ministries of Health, Energy, and Finance. The issues dealt with by this commission vary between investment planning, regulation and tariffing. Finally, the High Council of Water and Climate is the highest authority regulating conflicts. It usually deals with issues such as the national water policy and the master plans of integrated water resources management.

A set of tools is available to help the implementation of the various resolution mechanisms and empower their effectiveness to resolve water conflicts:

a) Legislation:

Law 10/1995 is the principal reference for dealing with water resources including conflict resolution. The Law is an advancement to the very old legislation which was unable to meet today’s challenges in the water sector. The main contributions of the Law are:

- A flexible and coherent planning largely aiming to prevent conflicts by fixing the rules of water sharing.
- Optimal and rational use of all water resources, by taking into account the priorities defined by the National Plan of Water.
- Adoption of the hydraulic basin as a geographical unit of planning and decentralized water resources management.
- A quantitative and qualitative protection and conservation of water resources.
- Participatory approach of water management by involving the users in decision-making, thus making them easily accepting and implementing those decisions and hence minimising conflicts over the decisions.
- Introducing water charges for cost recovery and rationalisation of water use.

b) Water-service charges:

Although it can be controversial that water-service charges are likely to be a source of conflict not a tool for conflict resolution, one of the main objectives of water-service charges is cost recovery in order to ensure the sustainability of the water services. Interrupted services will certainly lead to people dissatisfaction which may escalate to violent conflicts. On the other hand, too high water charges that do not take into consideration the capacity of the poor are likely to deprive them of the services leading to unrests and conflicts.

c) User participation:

User participation in project planning and implementation is not new in Morocco and has been used successfully in many sectors. In the water sector, user participation has been concentrated in rural areas in three fields:

- Watershed restoration: the technical solutions for watershed restoration are expensive and especially unsustainable unless they are accepted by the populations settling in watersheds.
- Water user associations: Law 2/1984 sets the legal bases for the establishment and defining the roles of water user associations in irrigation projects. They are to participate in the management and operation of their irrigation projects aiming at achieving better use of all resources and maximising outputs.
- Drinking water in rural areas: water supply projects in the rural areas implement participatory approaches through which the local people are involved in all the phases of the projects; i.e. planning, design, implementation and

management. To help the largely uneducated people in the rural areas to understand and hence participate in those project, simple techniques are used which proved to be very successful.

4.4.3 Case Study 1: Irrigation Projects in Oum Er Rebia Basin

Oum Er Rebia Basin contains five large-scale irrigation projects with a total area of 280,500 ha, accounting for 62% of the irrigable agricultural potential and 81% of the irrigated area in Morocco. Two public organisations operate in the Basin: Oum Er Rebia Basin Agency, one of seven such agencies which were created by Law 10/1995 to provide decentralised management of the main water basins in the country; and the Regional Offices of Agricultural Development (ORMVA) who are responsible for the management, operation and maintenance of the irrigation projects as well as collection of water charges.

Conflicts in the Oum Er Rebia Basin started as early as the planning stage of those irrigation projects through the preparation of the Basin's Master Plan. Representatives of the agricultural sector disputed that the Plan was allocating larger shares of the water resources in the basin for drinking purposes. In addition, disputes over water allocation within the agricultural sector erupted between the representatives of the upstream areas and those of the downstream areas. The upstream areas refused the fact that the Master Plan was favouring the downstream areas by allocating them larger water shares while the water originated in their lands. In fact, the planners had intentionally done so because the downstream areas had higher potential for agricultural production compared to the upstream areas of the mountainous terrain.

Similarly, new conflicts emerged after the projects started operation, the most critical of which was the dispute over water charges. According to Law 10/1995, the charges are to be paid by the water "extractor". For the water users in the projects, it was ORMVA who extracted the water to provide it to them and hence it was ORMVA who should pay the charges. ORMVA disputed this interpretation of the Law requesting that the water users pay the charges. It took the ministry supervising the Basin Agencies and that supervising ORMVAs a long time of discussions until a compromise was reached: the water users were to pay the water charges to ORMVA, who should hand the money over to the Basin Agencies after deducting a small percentage to ORMVA.

Conflicts between Oum Er Rebia Basin Agency and ORMVA are related to many issues. For instance, according to Law 10/1995 the Basin Agency is responsible for the overall integrated water resources management in the basin, where as ORMVAs are responsible for the management of groundwater for agricultural use according to another law. Typically, this creates conflicts between the two agencies over groundwater. In addition, ORMVAs usually disputes water allocation between sectors by the Basin Agency. At the beginning of each agricultural year, the Basin Agency assesses available water resources and allocates them to the various sectors according to the basin master plan. ORMVAs usually disputes the conservative approach used in the assessment of the water resources and demands for more water.

4.4.4 Case Study 2: Tadla Irrigation Project

The Tadla irrigation project located in the central part of Morocco is one of the largest modern irrigation systems in the country as it covers about 100,000 ha. The irrigation network comprises two large storage dams, a number of derivation dams, and about 2630 km of canals that are concrete-lined down to the tertiary level. Surface irrigation is widely practised in the project but only recently some areas converted to trickle irrigation.

Because of water shortage, the total available area cannot be irrigated. Since the early 1980's, a large number of relatively shallow wells (about 15 to 30 metres deep) was dug by the farmers. It is estimated that 8000 such wells are presently run by the farmers. Interestingly enough, wells are mainly concentrated at tail-end of the system reflecting the inequity of surface water distribution. Conjunctive use of surface and ground water is thus of large use.

Project management and operation is primarily the responsibility of ORMVA, but with emphasis on participatory irrigation management through water user associations. However, ORMVA Tadla is reluctant to totally transfer management duties to WUAs because they think that they are providing a good irrigation water service and that users are allowed to participate in decision-making at every level of ORMVA. Consequently, WUAs have had no real duties to do. Most of the evaluations agree that the WUAs in Tadla meet rarely, collect almost no charges from their fellow members, and hardly participate effectively in any decision making process.

Water is billed on volumetric basis; water tariff covers the operation and maintenance cost, and the rate of collection is relatively good.

Each year, ORMVA in Tadla receives on average of 800 to 900 claims from water users and verbalize about 500 to 600 infringements to irrigation systems rules. ORMVA affirms that 95% of the farmer claims are investigated and answers addressed to the claimers. Users, especially those at the tail-end of the system, usually claim that the flow reaching their fields is less than the expected water modulus (30 l/s). According to ORMVA, portable water measurement devices and proper procedures have been designed to verify the veracity of such claims and to correct water bills accordingly. However, many independent field measurements indicate a variability of actual flow reaching farm inlets.

Among the infringements to the rules, water stealing and vandalism are most common. It is difficult to have an exact assessment of the effectiveness of the ORMVA procedures to tackle such problems.

4.4.5 Case Study 3: Sector 'A' of Loukkos Irrigation Project

Sector 'A' of Loukkos, located in the north west of Morocco, is a collective sprinkler irrigation system fed from the storage reservoir of Oued El-Makhazine on river Loukkos by a triple-stage pumping system. Pumped water is discharged into a 60 m high, open reservoir serving as a regulating device. The reservoir feeds a network of buried pipelines down to the field hydrants. The hydrant is the lowest point in the system that is managed by ORMVA, below which farmers take the responsibility of managing their sprinkler systems. The system was designed to be fully on-demand, i.e. water was available in the hydrants all the time so farmers could irrigate whenever needed. The original system design assumed that farmers would collaborate to organise irrigation. Hence, the design adopted hand-move type sprinkler systems at the field level. To optimise the cost of the system, collective sprinkler systems were supposed to be shared by groups of farmers.

After successful operation for a few years after construction, the system experienced a rapid degradation of its performance because of various reasons:

- The water meters, which were of the derivation type, were easily clogged right in the beginning of irrigation. Additionally, because of low preventive maintenance, and very often because of vandalism, most if not all of the water meters rapidly became out of service.

- Operation and maintenance of the collective sprinkler systems became rapidly a burden for farmers. Many conflicts arose: Who will take responsibility for the management of the system? Who will stand guarding the system? Who will transport the pipes and store them at the end of the irrigation season? Who will pay for the repairs? etc.

- In addition, sprinkler robbery became widespread: Farmers resorted to permanently guarding their sprinklers, skipping night irrigation, painting sprinklers with specific colours/marks, etc.

- To avoid conflicts arising from the use of the collective sprinkler systems, but also to withdraw large flows and reduce irrigation time, some farmers acquired their own sprinkler systems and started using them without prior coordination with the others. As a consequence of generalised high discharges in all parts of the system, a system-wide drop in pressure was observed disturbing normal irrigation network and equipment functioning, more particularly at the downstream of the system. This led ORMVA to

organize irrigation turns between branch/main pipes.

- As the water meters were all out of service, ORMVA had to resort to fixed water charges per crop. Farmers thus had no motive to rationalise on water use, but in fact they were encouraged to over use water leading to further worsening of the situation year after year.

- Over use of irrigation water led also to high water percolation rates, with rising water table, which in turn necessitated the construction of a system of open-channel drains (not initially provided by the project because of the deep sandy soils).

- The process was aggravated by the high energy cost of pumping. Electricity bills became so high that the rate of cost recovery became very low.

Recently, the project went under complete rehabilitation which included modifications to the original design. Most importantly, the idea of collective sprinkler systems was abandoned and replaced by individually-owned systems. Consequently, each farmer had his own water meter. The viability and durability of water metering is therefore questionable because of the high costs associated with water metering for small farms. Nonetheless, these modifications proved to be the most important factors in improving water use efficiency and cropping intensification, and in reducing farmer conflicts over irrigation equipment and water.

4.4.6 Case Study 4: Bitit Small-scale Irrigation Project

In contradiction to the previous two case studies, Bitit is a small-scale irrigation scheme built and managed by the farmers themselves. The scheme is located at the foot of the Atlas Mountains midway between the cities of Fes and Meknes. It has a total area of 5,000 ha out of which about 2,000 ha are irrigated (900 ha during the summer and 1,100 ha during the winter). The scheme is fed by water from three springs whose average discharge during the summer is estimated to be in the vicinity of 2000 l/s, out of which 800 l/s are diverted to Meknes city for domestic supply. The remaining water is used for irrigation.

The irrigation systems comprises one primary canal leading spring waters to five main canals which further branch into lower level canals. Recent system rehabilitation includes concrete lining of the main canals in order to reduce seepage losses and the construction of permanent diversion and flow division structures in order to facilitate water distribution.

The farmers in Bitit have both land and water rights. Water allocation rules are therefore very clear as they follow the water rights. The water rights are expressed as hours of full canal flow such that each shareholder gets the full flow of the canal feeding his field for a number of hours equals to his water right. Currently, irrigation is organised such that each farmer gets a turn in seven days.

Irrigation management used to be carried out by traditional organisations at the main canal level. At the beginning of every agricultural season, all the shareholders of a canal gather to: 1) elect a certain number of canal riders to oversee water distribution along the canals, 2) establish what they call the "Jrida" of the canal, i.e. the full list of shareholders and their water rights together with the exact locations of the fields they want to irrigate in the coming season, and 3) agree on the water distribution sequence during each irrigation turn. The "Jrida" is of paramount importance since it is the basic management framework which defines the water allocation and distribution rules by listing the exact date and time each shareholder will have the irrigation turn and for how long. The canal riders have the duties of overseeing the exact implementation of the irrigation schedule according to the "Jrida", conflict management and water stealing control.

Under such clear and transparent water distribution rules, it is no surprise that water conflicts are very minimal in Bitit. Farmers sometimes steal water though when they overestimate the area to be irrigated at the beginning of the growing season and find that their water share is not enough to cover crop water requirements during peak demand time. However, the tube wells presently provide a solution to this problem as farmers can buy tube well water on volumetric basis to supplement their surface water shares. This contributed to reduce water stealing.

Nonetheless, the main concern and sometimes source of conflict in Bitit is the municipal water diverted to Meknes city. The farmers are skeptical that the municipal water management agency of Meknes diverts more than its share of the spring water, at least during the peak summer season.

The free water market in Bitit enables the shareholders to sell their water shares separate from the land. One recent and tempting opportunity for them is a proposal by a water bottling company to buy their water rights. However, they face a legal constraint as Law 10/1995 prohibits selling irrigation water for non-irrigation purposes. The shareholders argue that their water rights are not linked to any agricultural use and hence this restriction by the Law is not applicable to their case. The dispute is now mainly judicial as it relates to the interpretation of the Law. This case clearly demonstrates how free water markets can be a source of serious conflict by detaching water from the land. It is true that by selling water to the bottling company the shareholders will be making larger profits per unit of water. However, this will come at the expense of the national interest and economy because the public investment made in the irrigation project will be lost if the water is used for non-irrigation purposes.

4.5 Yemen

Yemen is located in the south-western corner of the Arabian Peninsula. The climate is largely semi-arid to arid. Rainfall is abundant only in the southern uplands but diminishes to 100 to 300 mm in most of the north and east and in the coastal plains. Surface water resources are limited to springs, seasonal spate flows, and runoff from rainfall on the highlands. Groundwater is a main resource for Yemen but is currently being depleted at very alarming rates. The water scarcity in Yemen is so acute with a per capita share of freshwater less than 200 m3/year.

4.5.1 Sources of Water Conflicts

The case studies from Yemen are taken from the governorates of Taiz and Lahej in the south-western corner of the country. These areas suffer from severe water shortage for all uses. The problem in Taiz is very serious and complex where competition on water between the domestic demands for the city and agricultural demands of the surrounding rural areas is so fierce. The two groups of users take water from the same groundwater sources. Initially, the farmers had agreed to allow water supply agencies to drill wells in their areas to supply water to the city in exchange for a compensation package that consisted of certain public goods (including roads, schools, rural water supply wells, and dykes). However, due to uncontrolled groundwater abstractions for the city the framers realized the danger to their precious resource and became increasingly reluctant to enter into such deals. They now refuse to allow exploratory drilling and well development in their area leaving Taiz city with a serious water shortage problem.

4.5.2 Conflict Resolution Mechanisms

In all areas of Yemen there are community mechanisms for assistance and cooperation, usually along kinship or tribal lines, which can provide a basis for resolving conflict (Dresch, 1993). The most important of such community mechanisms is the tribalism as the major system of governance and community organization in most highland rural communities (Al-Shaybani and Al-Zubayri, 2005). Sheikhs and tribal leaders still play a vital role in settling disputes in these tribal areas and elected officials also have tribal affiliations, so that tribal and modern power structures largely overlap.

In non-tribal areas of Yemen, traditional and modern community institutions exist for water management and for dispute resolution. These can be highly evolved: as with the management of spate in Wadi Tuban (see case study below). In recent years, dedicated water management associations have emerged, most frequently for potable water supply. Some of these associations have grown into strong community institutions with a range of other activities like schooling, health services, rural roads and water for livestock.

On the other hand, modern mechanisms have also been added to the matrix. Under the Water Law, NWRA has regulatory powers over water management, and a number of disputes are now being referred to NWRA branches for a decision on the legality of well drilling, etc. In four basins – Sanaa, Taiz, Saada and Amran – government has now set up basin committees comprising representatives of central and local government and civil society. It is too early to tell whether this joint forum will be effective in imposing

order on water resources management. The new, elected local councils at the district level have a responsibility for all local affairs, and NWRA policy is to engage them in water resource regulatory activities. At present, the little evidence available suggests that this form of decentralization has multiplied rather than solved problems (Al-Shaybani and Al-Zubayri, 2005).

4.5.3 Case Study 1: The Court Intervention Settles Disupte between Two Villages over Drinking Water

In 1997, a dispute over spring water arose between two villages on Jabal Sabr, the huge mountain that towers over Taiz city. The dispute lasted until 2001, left five people dead and had to be resolved in the Court of Appeal after the intervention of the army.

The story began in the mid-1990s, when one village – Quradah – received government money (from the government's rural water supply agency) to rehabilitate its piped water supply system. This system was fed from springs belonging to Quradah which flowed into a collection tank. The tank, however, was sited uphill of a spring which belonged to a second village, Al-Marzooh. Al-Marzooh became afraid that the project would reduce the flow from their spring. In night raids, Al-Marzooh blew up part of the new project. The police made some arrests, and the governor visited the project site ordering it to continue. Al-Marzooh responded by blowing up more installations and equipment, and soldiers sent in only created further tensions. Although traditional mediation managed to get the case into court, the explosions continued and gun battles left five dead, together with more than twenty injured. The final court ruling was accepted with reluctance on both sides. The villages were to construct one collective tank for their water supply. Quradah could connect a 4-inch pipe, and Al-Marzooh a 2-inch pipe, with a pro rata reduction in supply in case of shortage.

4.5.4 Case Study 2: Two Villages Protect Their Water Resources

Contrary to the previous case study, this case documents the cooperation between two villages to protect their water resources. Al-Kareefah and Al-Dhunaib are neighbouring villages in the very water scarce Qadas area of Taiz governorate. Each village has its own drinking water scheme with its own management committee. Having seen the problems of water scarcity in other parts of Qadas, the two villages cooperate to protect the drinking water resource which is their first priority.

The committees keep an eye on the activities of local farmers and have stopped the digging of many new wells. In one such incident, a farmer from Al-Kareefah started to drill a new well after taking a permit from the National Water Resources Agency (NWRA) branch office in Taiz. The Al-Kareefah water management committee entered an objection with NWRA, which then cancelled the permit and stopped the drilling. Another farmer, this time from Al-Dhunaib, failed to get a permit but started to dig a well anyway, stealthily by night. By the time the village found out, the well was more than 20 meters deep and lined with reinforced concrete. The farmer threatened to kill anyone who came close to the new well. The Al-Dhunaib water committee chairman convened a meeting of the whole community and it was decided that the well should be filled in. Faced with this community solidarity, the farmer had no choice but to agree, and the whole community took part in filling in the well.

Ironically, the committees had the most problem with the official rural water agency, the General Authority for Rural Water and Sanitation Projects (GARWSP). GARWSP started to drill a borehole in the catchment area of the existing drinking water schemes of both villages, and within 400 meters of an existing well. The committees pointed out to GARWSP that this violated the 500 meter minimum spacing rule, but the protest fell on deaf ears. The two villages were on the point of resorting to violence to stop the contractor when it was learned that the new well was dry. GARWSP made a second attempt to drill, this time within 200 meters of the water source of Al-Kareefah and in the direct catchment area of Al-Dhunaib's water source. However, this second attempt was faced with such fierce resistance from both communities that the contractor was forced to leave the area. The two committees then decided jointly to dig a hand dug well for community use at the site in order to prevent GARWSP from any future attempt to drill in this location.

4.5.5 Case Study 3: NWRA Settles a Dispute between Farmers

A conflict between villagers from Al-Sayani district of Ibb concerned a new well drilled close to an existing neighbour's well and without permission. The dispute started when the existing well owner made a complaint to NWRA, asking that they stop a farmer who was digging a new shallow well upstream to his. NWRA visited the site, where its team found that the new well was in fact close to two existing wells. The first of these belonged to the complainant and was about 120 m downstream of the new well. The second existing well belonged to the farmer who was digging the new well, about 120 m upstream of the new well. As it turned out, all three wells were dry at the time of the visit of the NWRA team because the visit took place during the dry season.

Although the new well breached the 500 meters minimum spacing rule, NWRA proposed that it be regularized on condition that it is used for the drinking supply of the villagers – only surplus water during the rainy season could be used by the well owner for irrigation purposes on condition that he paid the capital and operating costs of the well. This deal was agreed and confirmed in writing by all concerned.

4.5.6 Case Study 4: Spate Irrigation Scheme in Wadi Tuban

Wadi Tuban spate irrigation scheme is located in Tuban District of the Lahej Governorate in the south of Yemen. The spate irrigation scheme is in the wadi delta with about 11,046 ha of cultivable land and extends from the hills at Dukeim, about 55 km north of Aden, south to the Gulf of Aden. The catchment area of the Wadi extends some 100 km northwest to Taiz and Ibb in the southern uplands with a total catchment area behind it of 5,060 km2 with average annual rainfall of 465 mm. Most of the rainfall on the catchment occurs in August and September, resulting in higher spate flows during these two months.

Flood water is the main source of irrigation water in Wadi Tuban. The average total run-off is about 80.6 million cubic meters per year (MCM/Yr), divided as 24.8 MCM/Yr of base flow and 55.8 MCM/Yr of flood flow. Nonetheless, the use of groundwater for supplemental irrigation, especially for cash crops such as banana, is on the increase. The number of wells in the command area has increased from about 26 irrigation wells in 1961 to about 2000 dug wells or boreholes in 1999. Yet, groundwater in Wadi Tuban is not used for irrigation purposes only: about 19 tube wells abstract groundwater from the Wadi to Aden for domestic and industrial use. The unregulated use of the groundwater leads to rapid decline in the water table.

Wadi Tuban flows from north to south. At Ras Al-Wadi weir it branches into Wadi Saghir to the east and Wadi Kabir to the west. The weir at Ras Al-Wadi is designed such that large spate flows are divided equally between Wadis Kabir and Saghir. For small spates, flow is directed to each wadi in turn using a bulldozer to construct temporary earthen guide bunds in the wadi bed. Ten permanent concrete weirs on Wadi Tuban and its branches divert spate flows to the off-taking canals.

Water rights and distribution in Wadi Tuban follow historical rules. Generally, the traditional upstream first rule – al 'ala fa al 'ala – governs irrigation turns both between and within diversion structures and canal branches by which upstream farmers have the right to a single full irrigation before their downstream neighbours can irrigate, and so on. An irrigation council composed of officials and of representatives of the water user associations is by law responsible for deciding on the rules of water distribution and assisting in the management and maintenance of the irrigation structures. Practically, the irrigation council is only advisory and its decisions are not binding. Spate management in Wadi Tuban is therefore haphazard as the organisations involved and their responsibilities are not clear, especially to the farmers.

Recently, the Irrigation Improvement Project in Yemen started in Wadi Tuban to rehabilitate some of the irrigation structures and establish formal Water User Associations as a modern and more organised method for spate management in the Wadi.

The construction of permanent diversion weirs along the wadis, in addition to the traditional earthen diversion bunds (oqmas), and the rapid increase in wells for irrigation have resulted in reductions in the spate flows

reaching the tail-ends of the wadis. Farmers at the tail-ends said that, in the past, they used to have access to spate water once every two years on average; now the interval is five to ten years. They believe that upstream farmers are taking more water than before, thanks to improved concrete diversion structures and to the upstreamers' influence over the management agencies. They believe that the traditional upstream first rule is abused by big farmers upstream who are expanding their irrigated area, getting up to four floods a year, and even planting the water-consuming bananas.

However, the downstream farmers have not lodged a complaint. This is in part because they are unsure which agency is now responsible: they believe that in addition to the Irrigation Council, the Ministry of Agriculture's Irrigation Department and the new elected local authorities all have a say. They do not know where to complain, nor what the rules and penalties are. They do believe that it would be a long and expensive business to complain, and they grudgingly accept that the nature of spate flows is uncertain and that spate water rights for downstreamers are hard to assert.

Farmers in the middle of the Wadi share the same views with those of the tail-enders. In addition, they reported some disputes between the farmers on irrigation priority. Such disputes occur only when the spate flow is small.

Ironically, farmers at the head of the Wadi also have complaints about the accessibility to spate water. They said that in the past they used to irrigate from spate water up to three times per year, but now it became difficult to get such a number of irrigations. Farmers think that the reasons behind the reduced access to spate water include the abuse of water distribution by the powerful and wealthy farmers who can break the water management rules in the Wadi and the corruption of some government staff.

The case of Wadi Tuban reflects findings from previous studies in spate schemes which showed that the benefits of spate improvement could go largely to the better off upstream farmers (Lawrence & van Steenbergen, 2005).

4.6 Djibouti

The case of Goubeto village in rural Djibouti is illustrative of the important role of local and traditional authorities, in the absence of state intervention, in solving conflicts over the allocation of scarce water resources among community members. However, as a consequence of the severe and worsening water supply and sanitation crisis, the progressive loss of traditional values and the rise of previously marginalized voices (youth, women, etc.), a participatory and inclusive new structure was able to emerge and make water a priority for the central Government.

Goubeto was established in 1910 first as a maintenance facility for the railway under construction between Djibouti and Ethiopia, and later as a train station depot. The village is not connected to the national road network and, except for Djibouti city, is far from any major cities. It is located 71 km from the city of Ali-Sabieh, which is the district capital. Former railway workers and their families mainly inhabit Goubeto, along with settled nomads. The climate is arid and hot and the village is poorly endowed with water resources. Goubeto's water reservoir has a maximum storage capacity of 200 m3 per month. The reservoir's capacity is dependent upon the regular provision of fuel, which is subject to a quota and is delivered from Ali-Sabieh.

Until the early 1980s, villagers received potable water from Djibouti city and trucks supplied the precious resource twice a week. According to the villagers, at that time, there were no major conflicts over the allocation of water. Attracted by the reliable water supply and the availability of basic social infrastructures, nomads, who had lost their livestock as a result of severe and frequent droughts, progressively settled in the village of Goubeto. The settlement of nomads was further encouraged by the construction of a well in 1980, which supplied Goubeto with a certain amount of bulk water once a month. Water thus played a critical role in the growth and expansion of the village.

However, beginning in the mid 1980s, water supply in Goubeto became erratic and scarce, in particular during the hot summer seasons, due to population growth and the lack of proper maintenance of water infrastructure. As a result, conflicts over water allocation flared up on occasion between the settled populations and the nomads as well as between settlers themselves. For example, nomads would tamper with the water

reservoirs and canals and collect the water without prior agreement with local villagers.

The role of traditional authorities, like the village chief or the community of elders (Conseil des Sages), played a critical role in efforts to mediate and solve these conflicts. The Conseil des Sages also oversaw repairs of tampered water infrastructure and made decisions over water allocation. However, because of its physical remoteness, the village of Goubeto was never a priority for the central Government. As a matter of fact, technicians were rarely sent from the central Government to Goubeto to take care of some of the routine maintenance of water infrastructure. In spite of the involvement of traditional authorities in solving conflicts over the use of water, the community of Goubeto lacked the knowledge, financial capacity and political connection to find a long-term solution to its problem of an intermittent water supply.

In the late 1990s, as a result of worsening water quality, poor sanitation and hygiene, recurrent droughts and malnutrition, an epidemic of diarrhea broke out, killing a total of 12 people. The deteriorating water quality situation clearly posed a serious environmental threat to the resident population. Some of the villagers, with external aid support, decided to take action and lobby the central government in order to obtain public assistance and funding to improve the water supply and sanitation systems. The fact that villagers in Goubeto supported the political opposition provided another incentive for the Government to quickly react to the rapidly deteriorating environmental health situation in Goubeto.

As a result of the above developments, a water association was thus created in 2004 and currently acts as the interface between the central government and the various communities in the village. The association includes a broad representation of local stakeholders, including elders and delegates from youth and women groups. A project to drill a new well 1 km away from Goubeto is now underway and will be powered by a solar energy system.

Goubeto thus offers a useful case study that illustrates how traditional authorities can play a critical role in providing water to local communities. However, because of the physical remoteness and political seclusion of the village vis-à-vis the central government, the traditional authorities were unable to significantly influence decision-makers nor could they count on the availability of decentralized local water institutions. This dynamic changed with the establishment of a new water association, whose members, empowered by an externally funded project on environmental health, were successful in initiating the necessary links between the communities and the State.

5. Discussion and Conclusions

Conflicts in water-short countries

Water scarcity in MENA is increasingly affecting the economic and social development of most countries of the region. Resource scarcity is a natural cause of disputes and conflicts among the users of the resource. For a resource that is so vital such as water, conflicts and disputes can be far-reaching.

Water is almost everybody's business. All human beings use water, at least to stay alive. This literally gives every person within a community or a nation the right to become a stakeholder. Water conflicts are therefore not limited to special groups of people or special professions or businesses. However, because water is primarily used for irrigated agriculture in many countries in MENA, it is natural that the majority of water conflicts are concentrated in this sector. The frequency and intensity of water conflicts are usually higher in the rural areas than in the urban areas for the following reasons:

- The rural areas are the home for the agricultural sector, the main water user. For most families in rural areas, agriculture still remains the main activity for subsistence. Water is a key input in the agricultural business. Any uncertainty in this vital input not only means business losses but could lead to total loss of the business and threatens the prosperity of the supported families.
- Water in the rural areas is shared by various sectors; namely the agricultural, domestic, and industrial sectors; whereas in the urban areas water is mainly used by the domestic and industrial sectors.
- Most governments give higher priorities to the urban areas in terms of economic development including water allocation. In almost all MENA countries, the percentage of people with access to drinking water is higher in the urban areas than in the rural areas. In addition, the domestic water share per capita in the urban areas is usually higher than that in the rural areas, partly because living standards in the urban areas are higher.

Classification of conflicts

Water conflicts can be classified according to the following criteria:

- Parties involved: conflicts can be between individual users or user groups, between users and institutions, and between institutions.
- Stakeholders/sectors involved: conflicts can be within the same sector or between different sectors.
- Level: conflicts can occur at the local, regional and national levels.

Conflict resolution mechanisms

Each type and level of conflict has its main management and resolution mechanisms. However, they can be generally grouped as follows:

1. Conflicts involving users only: this type of conflicts has been and largely still is dealt with by the users themselves. Seldom are authorities involved in the resolution of such type of conflicts. In the rural areas, community leaders and influential people are key players in settling disputes. Yet, they do so based on customary laws and regulations that have been established a long time ago and are respected by everybody in those communities. In addition, the solidarity and cohesion of the rural communities help them confine and resolve their conflicts internally. In fact, the social customs, traditions, values and kinship ties – from which those communities obtain their solidarity – are in most of the time important factors in minimising or preventing water conflicts at the first place. It is too great a risk for someone to start a serious dispute with his neighbour to jeopardise his relationship with the rest of the community.

2. Conflicts involving institutions: this type of conflicts is typically resolved through the authorities and in some cases through the judicial system. In some countries, special institutions or committees have been established to deal with such problems. Otherwise, the conflicts are dealt with by the ministries under which the disputing authorities work and/or other stakeholder ministries/organisations. If all fails, the disputes are referred to the judicial system. In such cases, it is very likely that a resolution is not reached quickly because of the long procedures of the judicial system.

User participation in conflict management and resolution

In facing the challenges of water management and allocation, different types of informal water organisations emerged and evolved. Those organisations proved very successful in organising irrigation schedules and water distribution among the shareholders. Such an environment helped the process to go smoothly and prevented conflicts from taking place. Moreover, the organisations were also effective in resolving the conflicts which occurred from time to time.

It is interesting to note how some of the informal water user organisations have many features in common although they exist in very distant parts of the world and have no means of communication. One sheer example in this respect is that of the water user organisations in the oases in Egypt and those of the "ghanat" in Iran. Although the context is slightly different, the characteristics and fundamentals of those organisations are very similar:

- Both organisations are primarily responsible for water allocation and distribution among the shareholders.
- They proved to be efficient means of preventing water conflicts because:
  - their members are elected/selected by the shareholders for being trustworthy and fair people; hence they are respected by the whole communities
  - they function in a transparent manner
  - customs, traditions and social values are very important factors in controlling people's behaviour and minimising open conflicts and disputes.

Following the success of informal water user organisations, many countries embarked on the establishment of formal water user organisations. This move was in many cases part of a total reform of the water sector which included among its objectives increased user participation in water resources management. However, experience has shown that so far some of those new water user organisations have not been able to achieve their full potential yet. In fact some organisations have been very successful, while others have been complete failures. The reasons behind such a variable performance are not preciously known yet. Monitoring and evaluation of the performance of water user organisations is essential in order to assess their effectiveness. Continuous institutional support is required in order to assist them until they mature and become fully independent.

Shortcomings in some conflict resolution mechanisms

The countries of MENA have some similar and some dissimilar conflict resolution mechanisms. It seems that some of those mechanisms can be at the same time sources of conflict themselves. Examples of such cases are the water laws, water tariffs and user participation.

Despite recent updates in the water legislation in some MENA countries, there are still many shortcomings that need to be resolved:

- The water legislation still suffers from gaps that open doors to water conflicts. It is a very well-known fact that when disputes are referred to the judicial system, lawyers seize any gaps in the law to try to win a verdict for their clients.
- The legislation is not always clear leading to misinterpretation which is again a source of conflict.
- The judicial system is overburdened by long bureaucratic procedures that are difficult to follow, take a very long time and can be costly. This contradicts the nature of most conflicts in general and water conflicts in particular which need immediate resolution.

Water-service charges are usually levied in order to recover some of the capital cost and most of the operation and maintenance costs of delivering the water with the objective of maintaining the sustainability of the water resources and services. However, if the charges do not take the social and economic aspects of the people into consideration, such as for example

using scaled tariffs for domestic water, they become a serious source of conflict between the users and service providers (government organisations, private companies, etc.) or among the users themselves.

User participation in project planning, implementation, management and operation proved to be a successful tool for preventing or minimising conflicts. This will hold true only if the beneficiary participants consider the benefit of the wider public, being a community or a whole nation, from the projects. Seeking personal interests and benefits by beneficiary participants can in many cases at least seriously hinder the progress of important projects if not halt them completely. Education and public awareness campaigns are important tools for stopping such a behaviour.

The inability of the water users to resolve conflicts over shared resources forces them to search for individual solutions (e.g. dig their own wells). The individual solutions might appear appropriate in the short term, however, they could lead to more adverse consequences on the long term (e.g. competition between too many and close wells). It is in the interest of whole communities that disputes and conflicts over shared resources, especially water, be resolved in an efficient and timely manner in order to maintain the solidarity and cohesion of the communities, thus ensure sustainable use of the resources.

- **Conflicts in countries with sufficient water resources**

  Water conflicts are not entirely associated with water scarcity: even in countries with generous water resources such as Iran, disputes and conflicts over water arise at the national level as water is transferred from regions with surplus resources to those in shortage. Unfortunately, such disputes are not based on sound technical or socio-economic reasons, but on political and personal interests that do not serve the overall benefits of the countries.

6. Recommendations

- Water user organisations, whether formal or informal, are and can be very effective means of conflict minimisation and resolution. Although formal water user organisations have had some relatively long history now in MENA, they are generally not mature yet and need continuous institutional support until they become efficient, sustainable and independent. The models of formal water user organisations should not be necessarily copied every where as a move towards modernisation and sustainability of the water sector. Informal water user organisations in indigenous irrigation schemes in MENA have proved to be equally, if not more, efficient.

- Adopting the participatory approach in water resources planning, management and utilisation is very important in minimising water conflicts. User participation in the formulation of solutions to existing and potential problems as well as reaching agreements on water allocation and utilisation ensures the acceptance of the wider communities to the reached decisions and secures their sustainability thus minimising water conflicts. However, it is essential for such an approach to succeed that public institutions be willing and learn to give room to user participation.

- It is essential that the water legislation be continuously updated in order to keep pace with the dynamic nature and continuous challenges of the water sector and its demands. In particular, updating the legislation should close all the gaps and clear any ambiguities.

- The judicial system should be freed from the bureaucratic procedures that hinder its activities. Special simple procedures for dealing with water conflicts and disputes can be introduced in the system in order to simplify and speed up the process, thus making this tool effective in water conflict resolution.

- Water-service charges are not necessarily efficient means of water rationalisation; however, they are important for protecting the investments made in the water services and maintaining their sustainability. Realising these objectives requires that water-service charges be based on actual water consumption not on flat rates. In order to avoid dealing with very large numbers of water users in the agricultural sector, water-service charges can be applied at high levels in the system and the responsibility of dividing those charges among the individual users be given to the water user organisations.

- The water tariffing system should take into account the financial viability of the organizations operating in the water sector and the user's capacity to pay in order to maintain its sustainability and to avoid conflicts.

- Education and public awareness campaigns are important means of changing people's behaviour and way of thinking, thus minimising or preventing certain types of conflicts and disputes. Similarly, training of government staff within the water sector is essential in order to continuously upgrade their skills and build their capacity in dealing with the new challenges they face during their everyday business.

- The out of basin transfer reduces conflicts and helps overcome water shortages at places where water is transferred to, nevertheless, it creates conflicts, or increases the severity of conflicts if they already exist, at the supply side, from where the water is transferred.

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