

Water crisis: The situation in the Middle East

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Introduction

A major characteristic of the Middle East and north Africa (MENA) is its aridity with short rainy seasons and high evaporation rates. Water with only a few exceptions, is scarce and precious. Therefore, it is not surprising that water and irrigation engineering had their birth and beginning in the Middle East.

In Mesopotamia, water of both the Euphrates and the Tigris Rivers was utilized for land irrigation initiating irrigation techniques and construction of irrigation canals.

In Egypt, the Nile water was harnessed for irrigation, thus initiating and promoting Egyptian water engineering and land surveying.

In Bilad Ash Sham (Jordan, Syria, Lebanon and Palestine) where 90% of the area is semi arid and devoid of any perennial water sources, man was obliged to develop special techniques to survive during most of the seasons. Several examples of constructions related to water utilization are well preserved in the area.

The oldest known dam in the world stands in Jawa in the northeastern part of Jordan as a witness of the need to collect water; it is 5.5 m in height and around 5200 years old.



Another impressive example, is the water supply of Petra, where a spring in Wadi-Musa village was diverted to the city through a system consisting of inter-connected network of ceramic pipes hanging 4-6 meters above ground, on the side rocks serving drinking purposes. An open channel was also constructed to serve other uses.

In each village, settlement, house, or tent cisterns were the most essential part. Without it, no survival. Rain water was diverted into these cisterns to be used during the dry period of the year.

The above mentioned examples illustrate the ingenious measures inhabitants of the area has developed to assure their survival throughout the course of history. Forced by necessity, technicians of all civilizations worked to develop the hydro-technical infrastructure without which none of the ancient empires could have developed or survived.

The question now is whether such structures can assist in alleviating the water supply shortages in the MENA area?.

The history of humans in MENA region throughout the last three to four millennia has been determined and shaped largely by one major infrastructural element, water.

This essential resource has great influence over human life when it is scarce. In the MENA countries the lifestyles of people, their socio-economic status and their conflicts have all been determined by this basic factor; WATER

Agriculture developed when the amount of rain was sufficient to support plant life. Irrigated agriculture was practiced along water courses such as the Nile the Euphrates, the Tigris, the Jordan, the Orontes and other Rivers and around a large number of springs as well as the few oases in the eastern part of Bilad Ash Sham and in North Africa

Types of Ancient Structures:

1. Pools: Rainwater was collected in highly sophisticated pools which walls were constructed of building stones with capacities up to a few tens of thousand cubic meters.

2. Terraces: Such structures were built on slopes to store water and control erosion. They are found all over the MENA area especially where precipitation rates are more than 200 mm/yr. Ancient terraces can easily be compared with recent ones.

3. Weirs: Weirs were constructed along wadi courses to collect floodwater. Their lengths were up to a few hundred meters with up to several meters of height.

Generally, successive weirs along a wadi course were built. The upper most one or two of which captured sediments and silt.

In recent years weirs started to be rebuilt in Jordan for purposes of irrigation, watering of cattle and artificial groundwater recharge.

4. Dams: Dams constructed along wadi courses served multiple purposes such as:

- Collection of water for the different uses.
- Diversion of water for irrigation and energy production (water mills).

Jawa is an example on these dams.

5. Playa Weirs (Barriers): Flood water joining playa becomes salty because of the accumulated salt at the bottom of a playa. A technique was developed in ancient times, starting 3000 years ago where barriers were constructed at the mouths of wadis pouring into the playas (Lancaster 1995). Behind these barriers fresh water was collected. The overspill water which collected in the play a became salty; there was also a fresh surface water body separated by a barrier from a salt surface water body. At present there is nothing similar being done.

6. Cisterns: Historic “house cisterns” are found all over the MENA region

House cisterns were the basic water supply units for families throughout historic times and until the recent developments of piped water systems. In some villages house cisterns are still used as the dependable water reservoir during the summer months.

Generally, cisterns are rock-cut, bell-shaped, symmetrically widening down. excavations, where joints and fissures appearing in the walls, were lined with different types of plasters; lime or sandy clays.

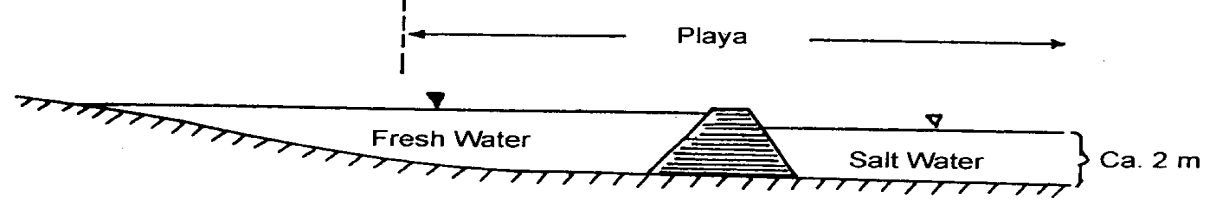


Fig. 1 Playa weirs (barriers). Fresh flood water coming from a wadi enters the playa. At the entrance (shown here) a wall is built to capture the water and secure it from the salinisation caused by dissolution of salts from the playa's bottom.

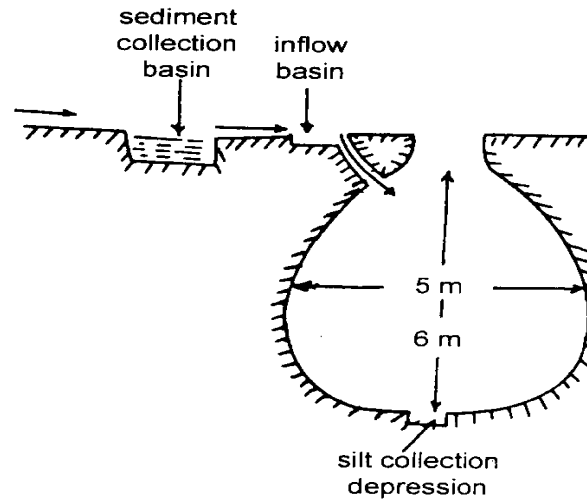


Fig. 2 The general shape of a cistern.

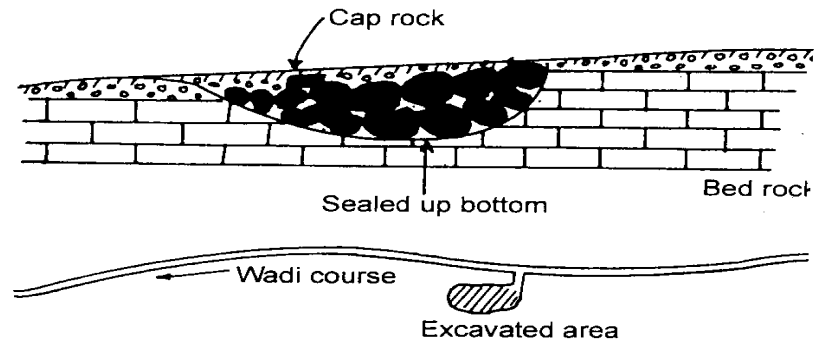


Fig. 3 A special type of wadi cistern.

In the past, the availability of water and the technologies used for its exploitation not only determined lifestyles and socio-economics but also limited the population to the number who could be supported by the amount of food produced.

In the last few decades the population growth rate has been very high, not only due to natural growth but as a result of the waves of refugees, redistributed in the area.

Despite the implementation of intensive water projects and conservation measures, water shortage remains the major obstacle to development in many MENA countries.

This puts specialists and politicians under severe stress concerning the future of the areas' economic growth, especially by considering the numerous water problems such as increasing demand, limited resources, depleting and degrading resources, overexploitation, exhaustion of non-renewable resources and pollution.

The whole of the MENA area development has been during the last 50 to 60 years concentrated in agriculture, mainly irrigated agriculture, which entails developing water resources to be used for irrigation.

Irrigated agriculture created job opportunities through less expensive investments for the population. This averted the potential catastrophes of poverty and hunger, and fostered domestic peace.

But, with the sharp increase in population and agricultural development, as well as the establishment of many small, medium-sized and even heavy industries the available water resources gradually became insufficient to meet development aspirations, especially because the spectrum of water uses has widened and the intensity of water needs has increased.

Population growth, higher standards of living, industrialization, irrigation and other activities accelerated the exhaustion of available resources.

Not only were renewable water resources used, but extractions were expanded to include the fossil-water resources, which have been stored underground for thousands of years. Some of these resources have been exhausted because their replenishment rates can not compensate the extraction rate. Others are now also threatened to meet the same fate.

Failure, in the past, to carefully plan some water projects has resulted in exhaustion or damage to some sources.

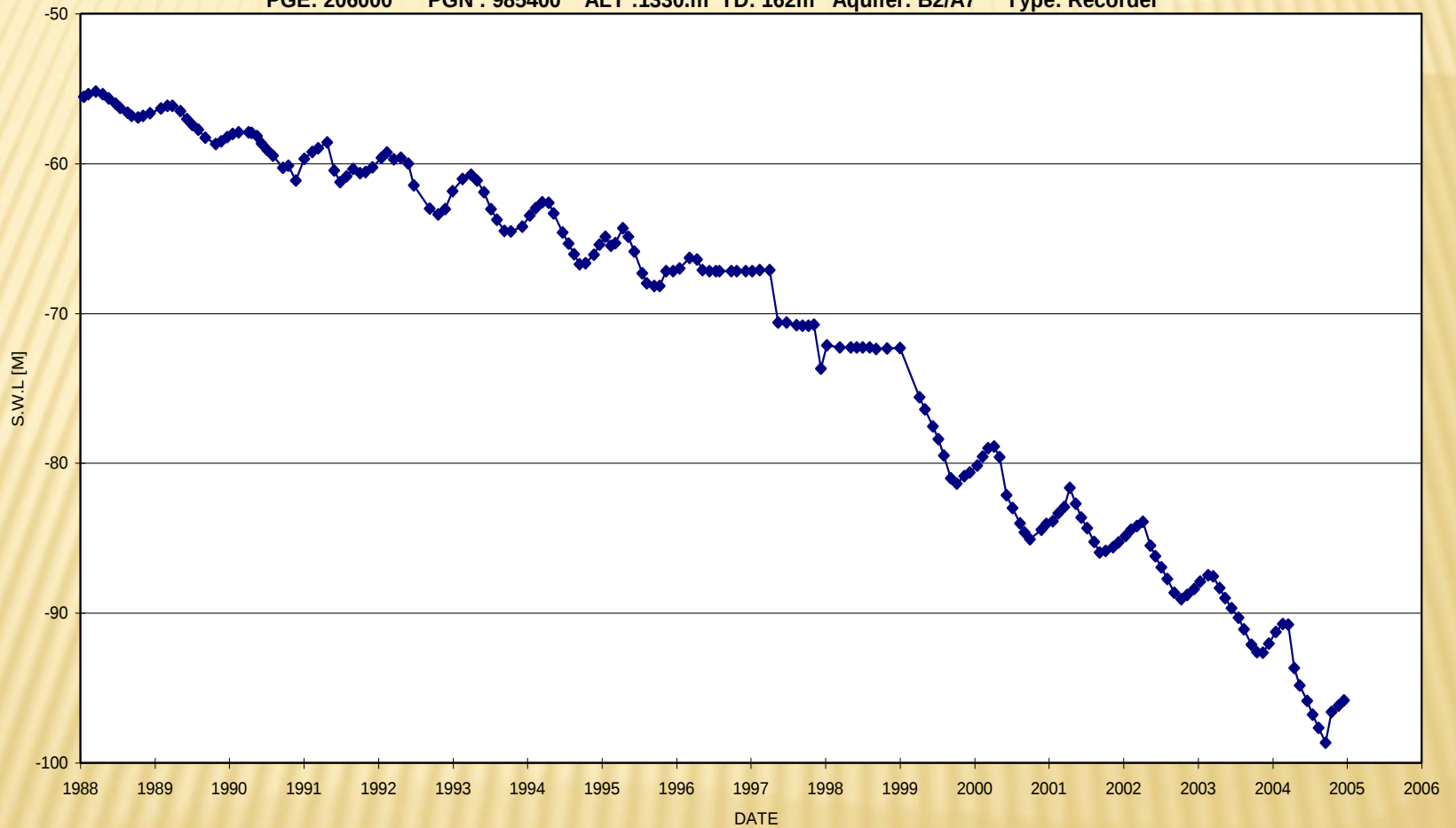
Overexploitation of aquifers on the account of the country's reserves of non-renewable and fossil water is gradually leading to aquifer depletion and exhaustion.

In certain areas, overexploitation is also leading to aquifer salinization by the mobilization of salt water bodies which are in contact with the fresh water resources.

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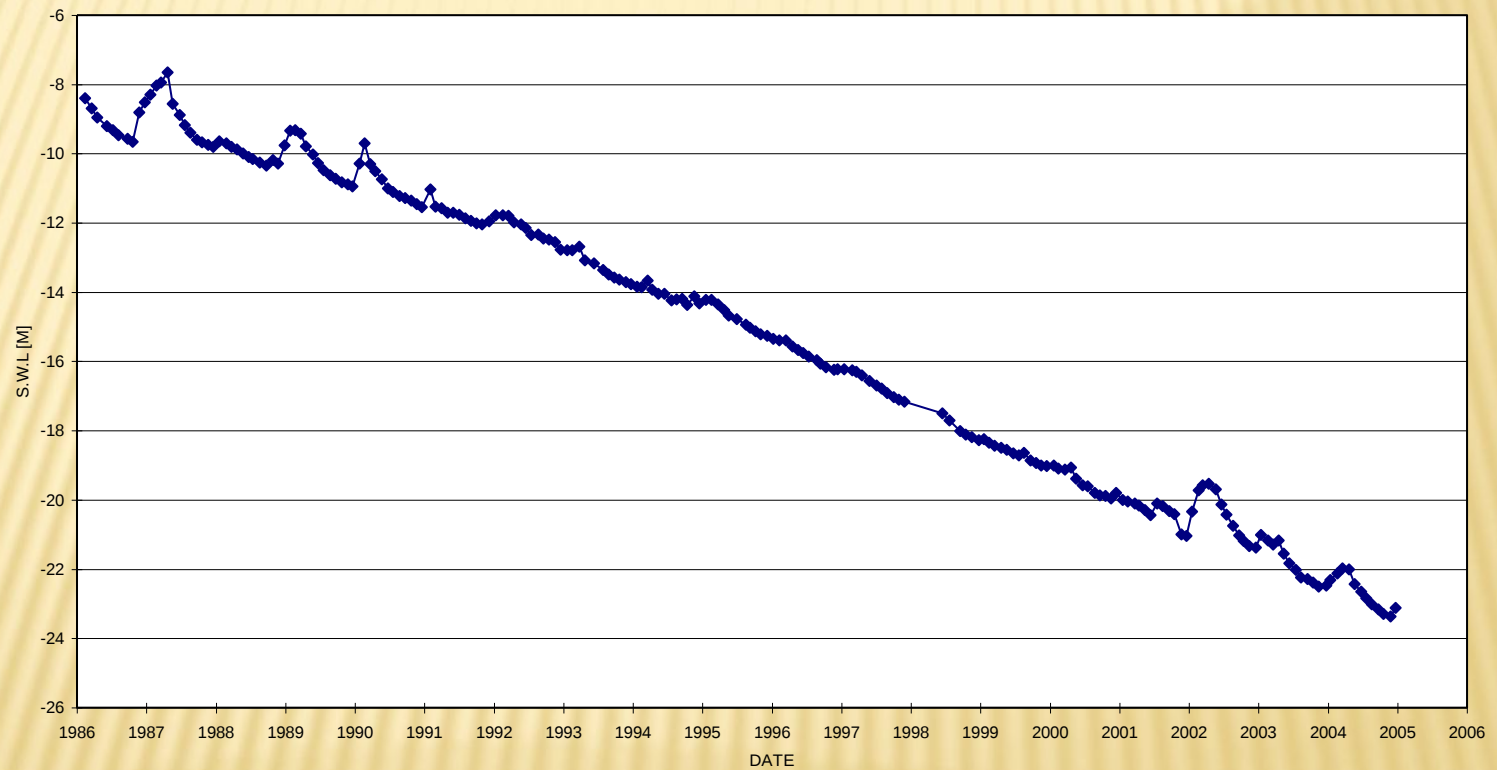
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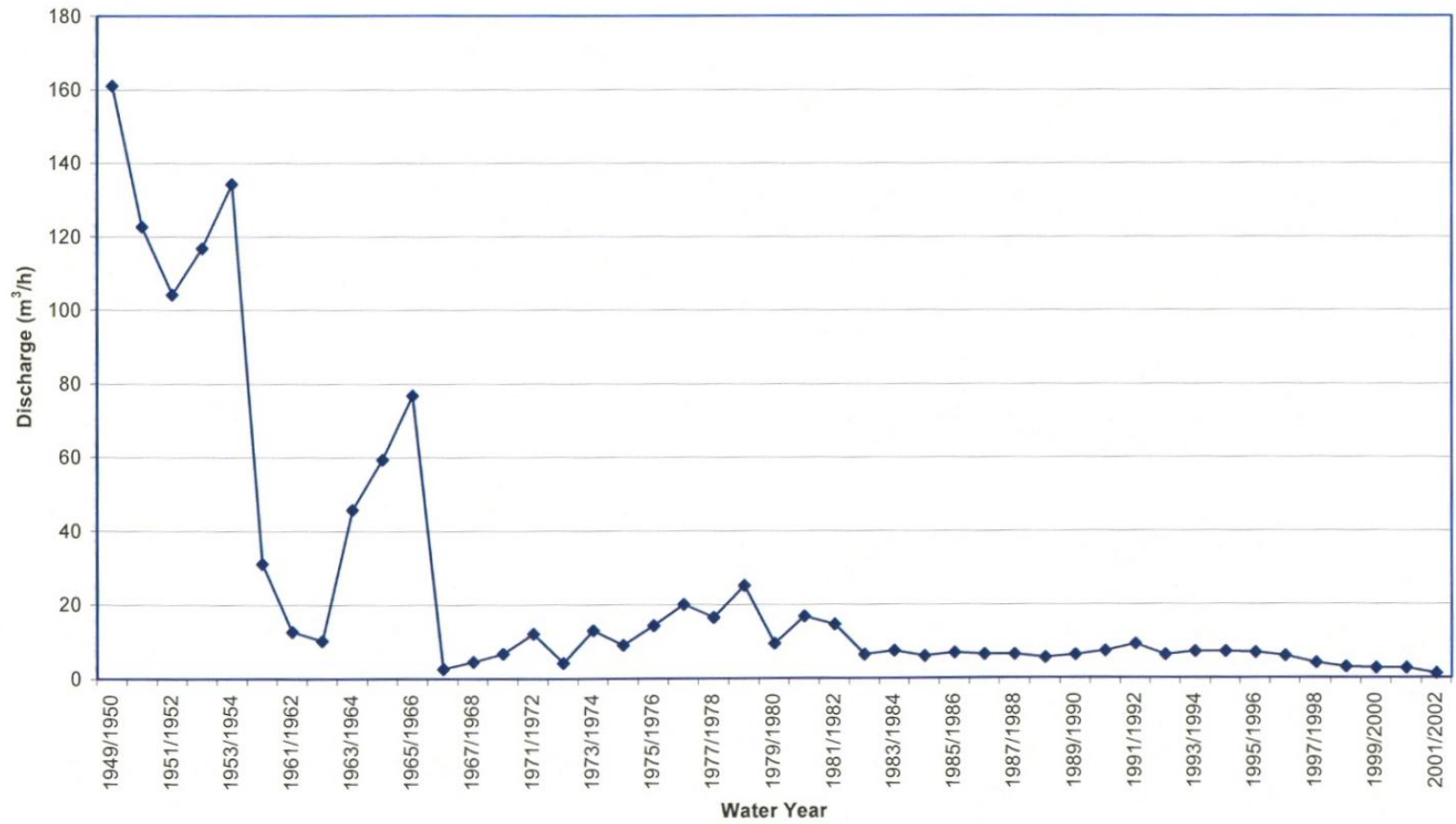
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AZRAQ BASIN

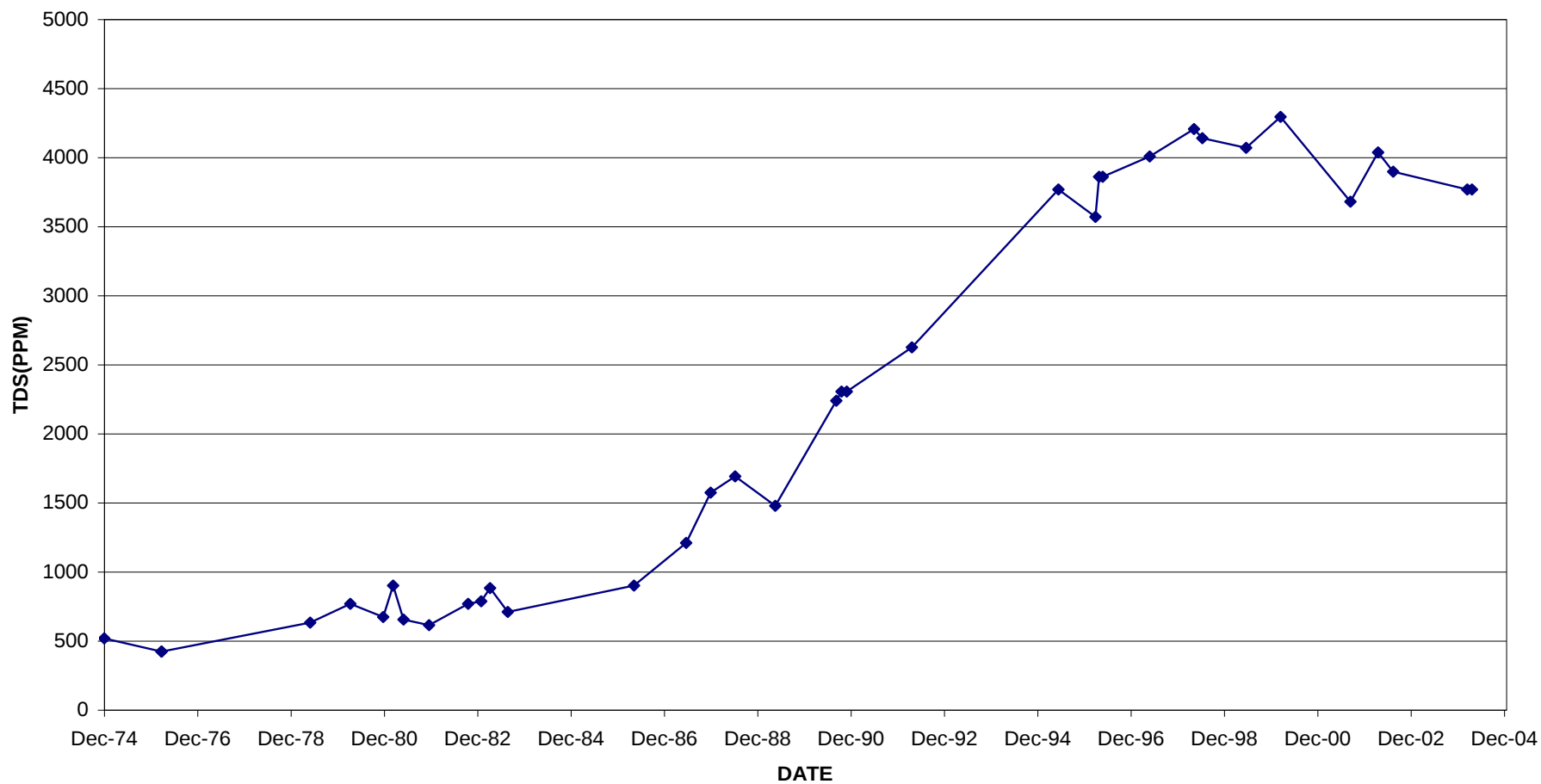
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AB0540: GHANNAM SPRING



**AL2335: PIPES MANUFACTURING CO.
AMMAN ZERQA BASIN**



EFFECTS OF CLIMATIC CHANGES ON SURFACE AND GROUNDWATER RESOURCES

During the last 4 decades precipitation records in the MENA area have shown general decreasing trend. Such decreases have certainly their impacts on the availability of surface and groundwater, on soil moisture contents (green water) and on the surface and groundwater qualities.

The results of many studies carried out in the MENA countries show that a decrease in precipitation of 10% will result in the reduction of flood runoff by about 24%, and a reduction in groundwater recharge of 29% in rain rich areas receiving more than 500mm/yr increasing to 59% in areas receiving moderate precipitation of around 300mm/yr.

Whether such changes in precipitation result from climatic changes or due to fluctuations in precipitation amounts from one year to another, the fact remains that the impacts on flood runoff and groundwater recharge are exponential and that should be given due consideration in the planning processes of water resources in arid and semi arid areas.

The consequences of climatic changes on the water resources are:

- Reduced flood flows.
- Reduced groundwater recharge.
- Reduction in soil moisture content (green water) and shorter periods of soils being wetted.
- Increases in both surface and groundwater salinities.

These consequences have themselves further implications on discharge of springs, water supply, air relative humidity soil temperature etc.

As a result of all these effects rain fed agriculture will reduce, water supply will decline, existing dams will become over sized and generally investments in many projects will be lost or will reduce in value, with all the socioeconomic ramifications of all the above mentioned impacts.

Such effects may also result in social unrest and uprisings

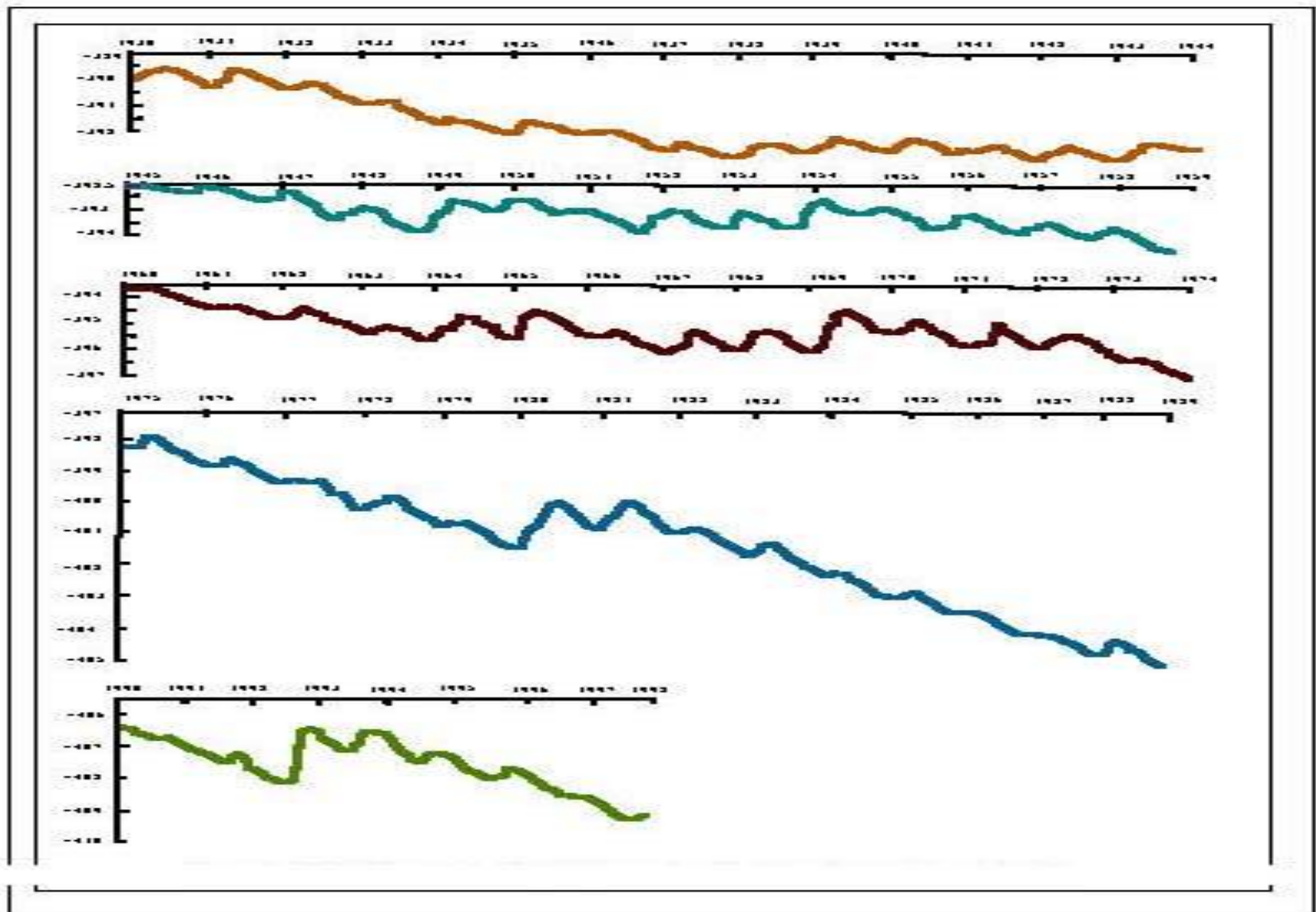
POLLUTION AND OVER EXPLOITATION

During the last four decades small, medium and heavy types of industries have been established in the MENA region, concentrated mainly in areas with available water resources.

Effluents from these industries are only partly treated and are directly discharged either into the nearby wadis or into the sewerage system, causing the deterioration of surface and groundwater quality.

But the major pollution problems are the result of inadequate treatment of domestic wastewater inefficient wastewater treatment plants, the choice of inferior waste water treatment systems and inappropriate reuse schemes.

DECLINES IN THE LEVEL OF THE DEAD SEA DURING THE LAST 5 DECADES





SINKHOLES ALONG THE NEW SHORES OF THE DEAD SEA



In the past four decades social and political issues determined the water use allocations in the MENA countries. But, the scarcity of water and the expenses of allocating new resources require new thinking and new management procedures.

Water allocations for certain agricultural activities may have to be curtailed, which may in turn cause difficult socio-economic and political problems (more expenditure on foreign currency, increasing unemployment, less food production and eventually social unrest).

The increasing demand for water and the competition among water use sectors made the management and development of the water sector through the policy of project-by-project, area-by-area or users group-by-users group planning insufficient. Therefore, the responsible agencies for the water sector have to develop water strategies with adequate dynamic instruments in them to enable comprehensive planning.

The change to an efficient water economy is not an easy task. But this change has to start. The technologies for that are available. Therefore, allocation of more funds to improving the efficiency of water systems is rendering unnecessary expensive, environmentally unsound projects, such as some of those carried out during the eighties and nineties.

The present shortage in water resources and the expected sharpening of demand should give rise to water policies involving more efficient conservation systems rather than the traditional search for new resources. The challenge facing us is to develop and introduce the necessary technologies for water and waste water systems. The increase in population makes this challenge more difficult. The traditional policy of developing new resources to satisfy needs is, in the case of MENA countries, almost exhausted. Now is the time to formulate new policies and change management strategies. Investment in leakage detection and maintenance is a more economical way to increase the efficiency of water supply. Water leaking from pipes represents a great loss since, although it has been collected, purified, pumped and distributed, it does not reach the consumer to pay for it.

It is now also necessary for waste water treatment and reuse to become an integral part of water services.

Although waste water is polluted, proper treatment can make its application in irrigation quite safe. It also has advantages over fresh water: waste water contains the nutrients necessary to support plant growth.

In the coming decades high-cost projects and environmental hazards will make large water projects unattractive and difficult to implement. Therefore, policymakers have started recently to change their strategies to lower the demand for and increase the efficiency of water instead of increasing the supply.

Deduction

The increasing demand for water, as a result of population growth and improvements in the standards of living, is gradually leading to competition for the water resources. Projects of additional supplies are becoming more and more expensive and very scarce because of the unavailability of additional resources.

Such a situation is expected to gradually lead to economic reconsideration of water supply and allocation practices.

Strategies and programs to be undertaken to improve the water situation

- Well drilling prohibition
- Putting a price for water to reflect its actual cost
- Metering and limiting the groundwater amounts abstracted for agricultural uses
- Introducing the principle of polluter's pay
- Raising efficiency of water use especially in the irrigated sector

Trans-boundary Groundwater Aquifers

-The necessity of their sound management-

Groundwater aquifers extending across international borders are defined as trans-boundary aquifers. Their recharge, flow, discharge, water quality and its genesis as well as the different ways of their interactions with surface water bodies, especially rivers are very complex issues, far more complicated than trans-boundary or jointly owned surface water bodies.

Therefore, the sharing of trans-boundary aquifer's water is a very complicate enterprise, which for many areas in the world, especially in the dry climatic zones has become a pressing issue not only for politicians and decision-makers, but also for water scientists.

Socio- economic development in arid and semi arid climatic zones depends to a large extent on the availability of satisfactory amount of water with suitable quality for the intended use.

Population growth, socio-economic development, rising living standards, industrialization, development of irrigated agriculture has led to imbalances between water supply and demand. And this situation has been sharpened by water resources depletion and quality degradation.

The low efficiency in water use, especially in the agriculture sector resulted in further worsening the situation. Therefore, supplying water has become the limiting factor for socio-economic development, and in some cases it has been reflected badly on human health.

The situation is presently best described as a collision situation and a socio-economic dilemma with strong implication on the social and political rest of countries.

Therefore, extraction of water extended to the exploitation of groundwater resources, whether renewable or non renewable. Many of these groundwater aquifers extend cross boundaries between countries and their exploitation has led to:

- Unfair exploitation between countries sharing the same aquifer.
- Affliction of hostile offensives on future generation's rights in the non-renewable water resources which form a part of the wealth for countries and their different generations.

The shared groundwater resources have in certain cases become a new era for conflicts, and over-exploitation and non-sustainability of the resources have become a dilemma for individuals, societies and governments.

Therefore, reasonable exploitation of groundwater resources within a country and its fair exploitation among riparian countries have become a social and political requirement locally, regionally and internationally.

International law and customary law cannot solve problems of shared groundwater resources. The present state of affairs requires other, more rapid measures and actions before such water becomes a new era for conflicts among countries and among the different use sectors; such as drinking, industrial and agriculture. Otherwise, social, economic and political stabilities within countries will be at risk.

The situation of the groundwater resources in the MENA countries can now be summarized in the following:

- The groundwater resources are over-exploited or are being mined.
- The groundwater quality is degrading by saltwater intrusion from underlying and neighboring waters.
- The groundwater resources are exposed to pollution by human activities of urbanization, industrialization and agriculture.
- Groundwater bodies extend across borders, a situation which renders fair sharing a necessity before projects established on these resources become a part of the socio-economic existence of population and hence of a country deserving the same defense and protection rights like those of territories, which may lead to conflicts or even to armed conflicts between countries.

Solutions within one country

-Groundwater within one country is solely in the possession of that country which has the full right to use it as wished. But, most countries especially the MENA countries are over-exploiting their groundwater resources under the cover of food security.

-Methods used in extraction, transportation and application are old and do not fulfill conservation requirements.

-None- renewable groundwater has to be considered as a strategic reserve and should only be used in emergency cases such as water crises and inability of supplying food from other sources.

-Agriculture projects depending on groundwater over- exploitation should be **re**considered in terms of intergeneration equity and justice.

- The poor and the indigenous population existence must be saved and defended against the big projects which use foreign workers, machinery, pesticides, insecticides, fuel, and where the only input from these countries is the non-renewable water, which should also serve coming generations.

With the elapse of time, it becomes difficult to stop big agriculture projects on non-renewable groundwater, because it might cause unemployment or shortage in food. **Here water demand management tools should be strongly applied. Such as:**

Application of water saving irrigation methods accompanied by support to family businesses.

Pricing water to covers its acquisition from other sources.

Application of groundwater resources protection from over- exploitation and depletion.

Dealing with groundwater, especially non-renewable groundwater in technical and engineering terms has become obsolete.

Ethics, intergeneration equity and water natural services must become the basis of dealing with such resources. Otherwise, continuing along the same lines will end up in social, economic and environmental catastrophes.

Now, the question is where is our ethics in dealing with our non-renewable groundwater resources, with our homelands, our nature and future generations for which

Shared groundwater resources

There are no international laws which govern the sharing of jointly owned groundwater resources or trans-boundary aquifers' water.

What is stated in the Helsinki Rules (1966), customary law (ILA 2004). Ballagio Draft Agreement (1998), UN resolutions and agreements and Berlin regulations (ILA 2004), can be summarized as follows:

Fair and reasonable use of resources across borders.

Avoid harm to others.

-Inform other parties about any actions which may affect their water resources.

But, these bases are weak and can not be considered as obligatory, or effective. They are effectively useless for any practical sharing of resources. The main reasons are that the groundwater has different movements, qualities, recharge histories, and yields. Therefore, no rules can be advanced to share such groundwater between countries.

Accordingly, shared groundwater resources require deep specialized studies which might lead to sharing agreements and joint management.

To achieve these objectives deep, sound and specialized, joint studies between partners sharing the same aquifer are very essential.

Combining these studies with political issue provides policy- makers with the means to take political decision for dealing with shared groundwater resources. The fair sharing of groundwater resources and their just exploitation require negotiations between sharing countries. This might lead some countries to reconsider their use of some shared groundwater resources, to a more fair and just use.

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The present situation, in most countries exploiting shared aquifers, does not at present form a strong socio- economic base for the population. And this situation must now be utilized to bring changes in water politics. Because increasing dependence on shared sources might lead to complications and conflicts.

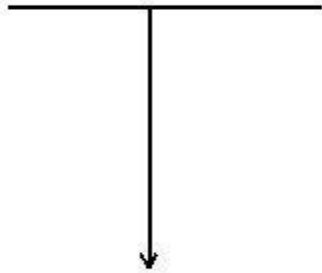
The fair sharing of trans-boundary aquifer water must be dealt with as a problem of emergency before the pressure on such resources makes their fair sharing impossible, because social and economic systems established on these waters have far reaching implications to peace and social rest in a country.

The international organizations, the UN organizations, the Islamic Conference, the Arab league, the African Countries Organizations and others should take the initiative to study the shared aquifers water in cooperation with the respective countries to ease the utilization of the water resources and to bring about joint management of these resources among countries.

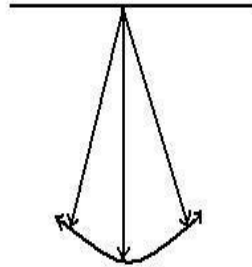
If the international organizations and the different countries do not put an end to the deteriorating situation of trans-boundary groundwater resource, especially in the MENA area, a situation which is expected to deteriorate in the future, nature will force its solution.

Such a solution will be expressed in fast depletion of resources and fast deterioration in their qualities.

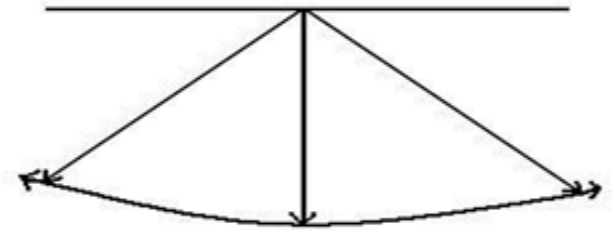
But such solution is expected to have very catastrophic social and economic consequences, which might threaten social security and political stability of societies and countries.



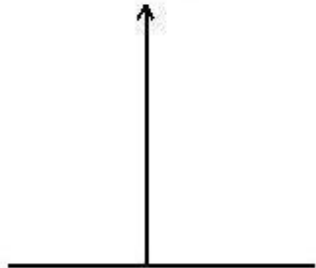
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Stable



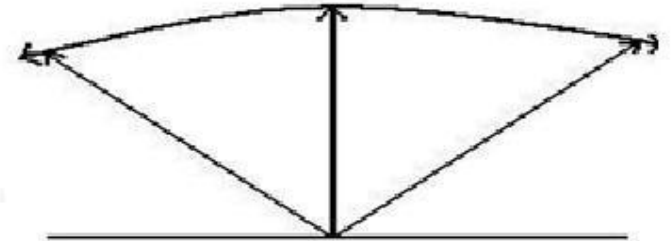
Unstable



Label



Very unstable



Catastrophically Unstable

THMs concentration in some samples

Location	CHCl_3 $\mu\text{g/l}$	$\text{CHCl}_2 \text{ Br}$ $\mu\text{g/l}$	CHClBr_2 $\mu\text{g/l}$	CHBr_3 $\mu\text{g/l}$	Total THMs $\mu\text{g/l}$
	1.2	8	27.7	33.8	70.7
Mix KAC + Peace water	1.6	10.9	35.4	47.6	95.5
Mix KAC+Arab Dam	1.7	15.2	48.1	56.2	121.2
Mix(KAC+Ziglab Dam)	1.2	12.5	41.5	73.4	128.6
KAC Deir Alla	3	2	1.6	1.7	6.5
Mixture of KAC and KTD water	4.6	22.2	61.1	67.3	155.2

Conclusion

Overexploitation resulting in groundwater depletion and quality degradation is indeed a real problem with negative impacts on societies and countries. But the major and direct problems and catastrophes which will affect the socio-economic situation of agricultur depending on these groundwater resources. Industries will be less affected and domestic uses have to resort to other sources, especially desalination which nowadays can be afforded by most users.

Unless proper programs are advanced to solve the problem, nature is expected to put its solution in the form of depletion and salinization of resources. But, this is expected to result in unemployment, poverty and social discomfort and eventually social and economic unrest.

Continuing along the same developmental lines in urbanization, industrialization and irrigation activities without the proper provision for wastewater treatment and reuse schemes, protection of surface water resources reduction in the use of fertilizers, detergents and biocides many problems will face the MENA countries with serious catastrophes in their municipal drinking water supplies, especially those resulting from eutrophication and trihalomethane formation.

Efficiency of water use in Irrigation should be raised. But this needs investments in equipment, devices and training which should be advanced by agencies responsible for the water sector in each country

This will not only mean increasing purification cost, but also advanced technologies with sophisticated control and care forced by higher risks of failure and risks to human health.

Water resources in the MENA countries should be given economic, social and political dimensions defining relations to upstream countries

Seeking and accelerating reaching at bi- and multilateral agreements with upstream countries

Allocating the necessary funds for water resources development, protection and conservation

Due consideration should be given to study the impacts of climate change on the water resources of the MENA countries

Security, stability and sustainability are the three pillars of future societies.

Security and **stability** were always at the agendas of countries since ancient times, but the outcome of the 20th century is a new concept which is **sustainability**, which should have a rank in human consideration equivalent to human rights, democracy, security and stability.

Many thanks for your attention

