UNESCO Series on Groundwater for MENARID 2

Opportunities for Managed Aquifer Recharge

Second Learning Workshop for MENARID Project Managers

11-14 December 2012, Amman, Jordan

Final Report

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UNDP

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International Hydrological Programme

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INTERNATIONAL FUND FOR AGRICULTURAL DEVELOPMENT

ICARDA

Ministry of Water and Irrigation

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Published in 2014 by the United Nations
Educational, Scientific and Cultural Organization
7, place de Fontenoy, 75352 Paris 07 SP

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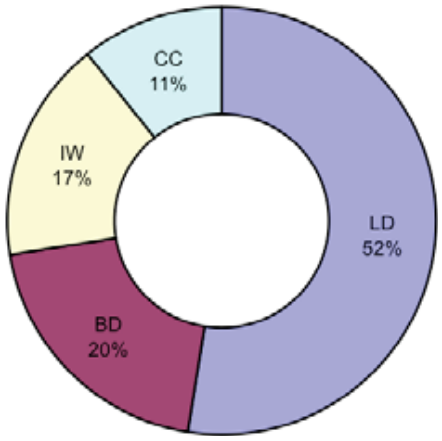
Background

Overview of MENARID portfolio

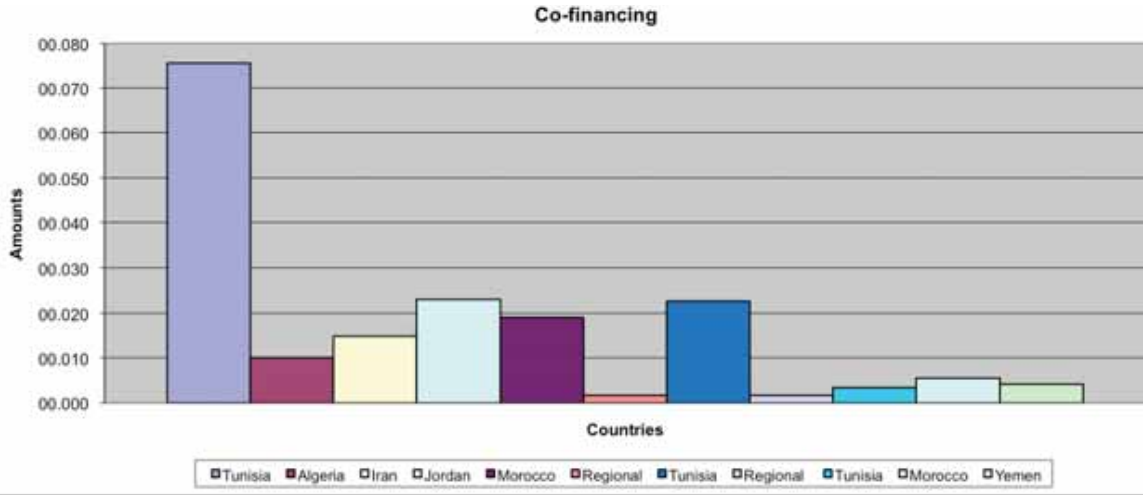
The Integrated Nature Resources Management in the Middle East and North Africa Region (MENARID) Programme, co-funded by the Global Environment Facility (GEF) and the International Fund for Agricultural Development (IFAD), includes 10 projects that cut across four GEF focal areas: Land Degradation (LD), Biodiversity (BD), International Waters (IW), and Climate Change (CC). Currently, six countries in the Middle East and North Africa (MENA) region are executing projects under the GEF MENARID portfolio: Jordan, Iran, Yemen, Morocco, Tunisia and Algeria.



In addition, the International Center for Agricultural Research in the Dry Areas (ICARDA) executes a medium size, cross-cutting GEF project on Monitoring and Evaluation (M&E), which also forms part of the MENARID portfolio. The objective of this project is to ensure that MENARID operations are monitored and evaluated in a coherent and systematic manner.

The overall objectives of MENARID are twofold: (i) to promote integrated natural resource management (INRM) in the production landscapes of the MENA region and (ii) to improve the economic and social well-being of the targeted communities through the restoration and maintenance of ecosystem functions and productivity. MENARID addresses the above-mentioned constraints and works towards further mainstreaming INRM, improving the governance of natural and water resources (groundwater and transboundary water systems), and coordinating investments that will: (i) promote enabling environments to mainstream the INRM agenda at national and regional scales, and (ii) generate mutual benefits for the global environment and local livelihoods through catalysing INRM investments for large-scale impact.

The purpose of the MENARID programmatic framework is to provide overall guidance in identifying strategic priorities for GEF investments in INRM in the MENA region. These strategic priorities should maximize GEF's impacts in achieving global environmental benefits through selected investments supporting the GEF focal areas for land degradation, international waters, biodiversity and climate change, while contributing at the same time to improving livelihoods and reducing poverty.



Country	Project Title
Tunisia	MENARID - Land and Water Optimization Project
Algeria	MENARID Conservation of Globally Significant Biodiversity and Sustainable Use of Ecosystem Services in Algeria's Cultural Parks
Iran	MENARID-Institutional Strengthening and Coherence for Integrated Natural Resources Management
Jordan	MENARID: Mainstreaming Sustainable Land Management Practices
Morocco	MENARID: Participatory Control of Desertification and Poverty Reduction in the Arid and Semi Arid High Plateau Ecosystems of Eastern Morocco
Regional	MENARID Cross Cutting M & E Functions and Knowledge Management for INRM within the MENARID Programme Framework
Tunisia	MENARID: Support to Sustainable Land Management in the Siliana Governorate
Regional	Reducing risks to sustainable management of the North West Sahara Aquifer System
Tunisia	Ecotourism and Conservation of Desert Biodiversity
Morocco	A circular Economy Approach to Agro-biodiversity Conservation in the Souss Massa Draa region of Morocco
Yemen	Adaptation to climate change using agro-biodiversity resources in the rainfed highlands of Yemen

Contribution of UNESCO-IHP to MENARID

Within this framework, the GEF IW:LEARN project has foreseen a regional sub-component "Support to MENARID Integrated Land/Groundwater Management," whose objective is to improve effectiveness in combating land degradation in MENARID by enhancing the role of groundwater and improving subsurface space management.

Due to it's leading position in groundwater research and expertise, UNESCO's International Hydrological Programme (IHP) was entrusted with the coordination of this sub-component. UNESCO-IHP will build on its projects and networks of specialists, including UNESCO water-related centres and chairs around the world, to provide assistance and expertise to the GEF MENARID multi-focal area projects by creating dialogue on the role of groundwater in land management and agricultural production. This includes the sharing of knowledge and best practices on groundwater management techniques in arid and semi-arid zones, in order to promote integrated land and groundwater management practices and solutions aimed at increasing the effectiveness of soil conservation efforts and more generally of land degradation and mitigation initiatives. These techniques include aquifer recharge management, water harvesting and the enhancement of traditional knowledge in MENA countries.

Rationale for the series of learning workshops

This regional IW:LEARN component involves the organisation of a series of structured learning workshops related to groundwater management covering all the MENARID projects in the GEF focal areas. An initial list of topics for these training sessions was outlined at the beginning of the project and endorsed by MENARID Project Managers.

First workshop on Traditional Knowledge

The first learning workshop for GEF MENARID Project Managers took place in February 2012 on the topic of sustainable water utilisation and harvesting practices in dry lands, with a focus on traditional knowledge, including rainwater harvesting practices and groundwater catchment systems, such as Qanats. The workshop "World History of Water Management".

Applying Traditional Knowledge in present-day Water Resources Management," was organised by UNESCO-IHP in Yazd, Iran, and was scheduled back-to-back with the International Conference on Traditional Knowledge for Water Resources Management (TKWRM) organised by the UNESCO Category II International Centre on Qanats and Historic Hydraulic Structures (ICQHS). It took place from 21 to 23 February 2012.

The key lectures included: 1) History of water resources management; 2) Traditional water harvesting systems in Iran; 3) Documenting and sharing traditional water knowledge: a participatory approach using video in qanats' rehabilitation; 4) Hydraulic structures: a historical overview, historical dams; 5) Early hydraulic systems – Ancient water supply strategies; 6) Different aspects of water/ rainwater harvesting; 7) Water ethics and religion: a historical perspective.

In cooperation with ICQHS, a number of field trips were offered to the conference and workshop participants as follows: 1) Mehriz: "Sadeghabad" Qanat, "Hassanabad Moshir", Garden of "Pahlevanpour", Abbasabad artificial recharge Dam, "Mohammadabad" Qanat; 2) Taft: "Khalilabad" village and Qanat. Qanat College of Taft, Water Mill, "Aharestan" Qanat, Taft Reservoir; 3) Meybod: The Two-Stone Water Mill, Ice House, "Shah Abbasi" Complex; 4) Yazd: Yazd Water Museum, "Amir Chakhmagh" Reservoir, Zarch (Payab), "Kooshkeno" Water Mill.

Second Workshop on Managed Aquifer Recharge

The second learning workshop for MENARID Project Managers took place from 11 to 13 (14) December 2012 on the topic of "Opportunities for Managed Aquifer Recharge (MAR)" and is the main subject of this report. The workshop was organised by UNESCO-IHP in cooperation with the Ministry of Water and Irrigation of Jordan, the International Center for Agricultural Research in the Dry Areas (ICARDA), the UNESCO International Groundwater Resources Assessment Centre (IGRAC), and the International Fund for Agriculture Development (IFAD). The target group for this workshop was the Project Managers of the MENARID portfolio. There was a good attendance from the projects, some of which also sponsored the participation of additional experts from relevant Ministries. The present report is a summary of the main organised lectures, presentations and discussions of the meeting and it will be published on the MENARID platform (https://menarid.icarda.org).

I. Lectures and Information on MAR - Day 1

I.1 Opening session

The first day of the workshop was opened with a series of welcome statements by H.E. Basem Telfah, Secretary General of the Ministry of Water and Irrigation of Jordan, Holger Treidel, Programme Specialist, UNESCO-IHP, and Aden Aw-Hassan, Director of Socio-economic and Policy Research Programme, ICARDA. All speakers stressed the importance of Managed Aquifer Recharge (MAR) as a useful tool for the wise use of groundwater resources and as a way to adapt to changing climatic conditions in the MENA region. The speakers thanked the participants and the project partners, in particular the hosting country and the Ministry of Water and Irrigation, UNESCO-IHP as well as ICARDA for their support and cooperation in the organisation of the meeting.

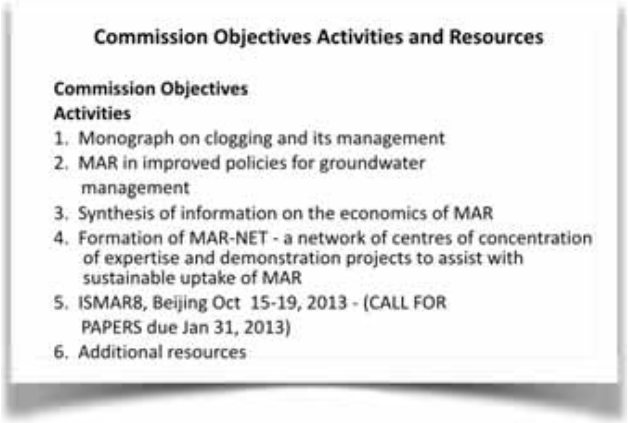
H.E. Basem Telfah highlighted that the Jordanian government has committed itself to using and managing water resources efficiently and equitably. All participants introduced themselves and expressed their areas of interest in the frame of the MENARID project.

H.E. Basem Telfah welcomed all the participants to Jordan. He stressed that water is one of the main issues in the country, not only because of limited quantity, but also because of the increasing population. Limited resources affect future generations and will affect Jordan's per capita share, which is 145 m^3 for all water use purposes. Jordan is far below the poverty line in terms of water and wants to share its experience with other MENA countries. He added that benefiting from each other's experiences is one of the most important tools for making progress. In countries with limited water resources, artificial aquifer recharge is one of the tools that should be considered and used as a way to deal with water depletion and water scarcity. He pointed out that guidelines for aquifer recharge had already been developed and presented at another workshop in Jordan. However the guidelines need to be further improved. He highlighted that agreements need to be reached on how to share in a sustainable manner aquifer resources that are shared with neighbouring countries. Due to the increase in various water-related activities, available water resources in Jordan have been reduced from 1.5 billion m^3per year to only 60 million m^3 per year.

H.E. Basem Telfah mentioned that Jordan uses treated water for agriculture. In Jordan 58% of water is used for irrigation, and the rest for industry and domestic consumption. He emphasised that irrigation is increasingly being done with treated waste water, meaning that there is a saving of fresh water for domestic consumption. He thanked all institutions for participating in the workshop.

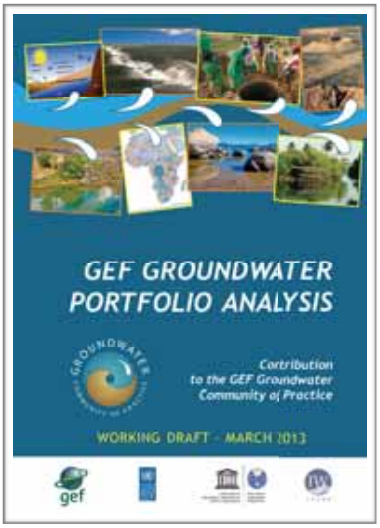
Lucilla Minelli, Project Officer, UNESCO-IHP, presented an introduction to the GEF IW:LEARN Project, (2011-2014) which serves, within the GEF International Waters Projects, as an umbrella framework for sharing knowledge and promoting replicable practices across and beyond the portfolio. The GEF Global Groundwater Community of Practice (http://groundwatercop.iwlearn.net/) was presented as a tool for bringing together experts and interested practitioners in groundwater resources management. The Analysis of GEF Groundwater Portfolio was also presented and MENARID Project Managers were asked to provide written contributions for the chapter dedicated to MENARID. The Analysis will be published as a joint UNESCO/GEF publication before the end of the IW:LEARN project (2014). Ms. Minelli presented also an

overview of best practices on MAR, following a short presentation prepared by Peter Dillon, Leader, Water Recycling and Diversified Supplies. CSIRO Land & Water, Co-chair IAH Commission on MAR.



Participants were reminded of the agenda (Annex I) and objectives of the workshop as follows:

- Provide MENARID Project Managers with basic knowledge on strategies for MAR in arid and semi-arid areas
- Encourage groundwater to be considered in the MENARID portfolio by providing expertise on specific aspects of groundwater management
- Facilitate better integration and involvement of Ministries responsible for land and water
- Plan joint activities within the portfolio (ICARDA).



IW LEARN

I.2 MAR lectures

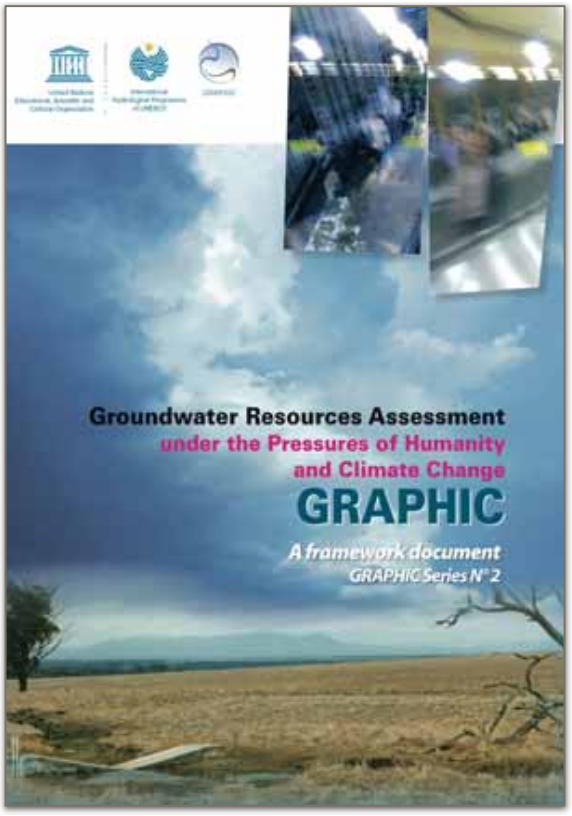
Holger Treidel

Mr. Treidel first presented the objectives of the training course in the frame of the MENARID project, and expressed his gratitude to the Ministry of Water and Irrigation for hosting the meeting. He went on to mention that the big challenge at global level is how groundwater recharge could help cope with climate change.

Concerning international agreements on climate change, countries contributing to the Doha convention have made a new commitment, in order to extend the Kyoto protocol for another eight years. Also countries have agreed to take appropriate measures to limit the consequences of global warming to a total of two degrees. However, this limit is already critical for sustainable water resource management, particularly in dry areas.

Water scarcity is an issue to which people from the MENA region have historically managed to adapt. The support that is actually needed is on how to effectively manage surface and groundwater resources in the region. Population growth, migration and urbanisation are the main drivers of climate change (CC) affecting the hydrological cycle. CC impacts the global water cycle, intensifies the hydrological cycle and modifies rainfall distribution, both regionally and temporally. From the Intergovernmental Panel on Climate Change (IPCC) report, a lower amount of rainfall is projected for the MENA region, which may be of crucial importance to groundwater resources (GWR). Globally, GWR are 100 times more important as stocks of water resources than surface water resources.

Groundwater resources are under pressure due to excessive exploitation, deterioration of groundwater quality (especially in shallow aquifers) and CC. Therefore it is important to undertake further research on the impact of CC on GWR. Mr. Treidel presented briefly the results of the UNESCO-IHP Programme: "Groundwater Resources Assessment under the Pressures of Humanity and Climate Change" (GRAPHIC) and drew participants' attention to the UNESCO publication of the framework document: GRAPHIC Series No 2.



The main conclusions are as follows:

- Improve understanding of GWR functioning
- Communicate knowledge to scientists and project managers
- Contribute to making GWR visible at the policy level
- Raise awareness on the opportunities that GWR can offer in adapting to CC impacts
- Acknowledge GWR as a cross cutting element in the MENARID portfolio.

GRAPHIC

DISCUSSION BOX

During the discussion it was suggested to increase the level of groundwater infrastructures for the benefit of the local population and also to think more broadly when talking about groundwater. For example, MAR is very useful in coastal aquifers, where the pressures are high and sea intrusion may occur. Planting crops more suitable for arid zones may reduce changes in landscape and biodiversity. Concerning climate change, we also need to look at impacts on a local scale, and to take into account the socio-economic conditions of local populations. Concerning groundwater pollution, once it has taken place it can be irreversible. Saving water in the MENA countries is very important. Aquifers in the region have been overexploited and in a future drier environment alluvial aquifers will be exploited even more. MAR is very important, as are strategies for CC adaptation, because there is a reduction in natural recharge. Soil conservation should be taken into account using an integrated approach.

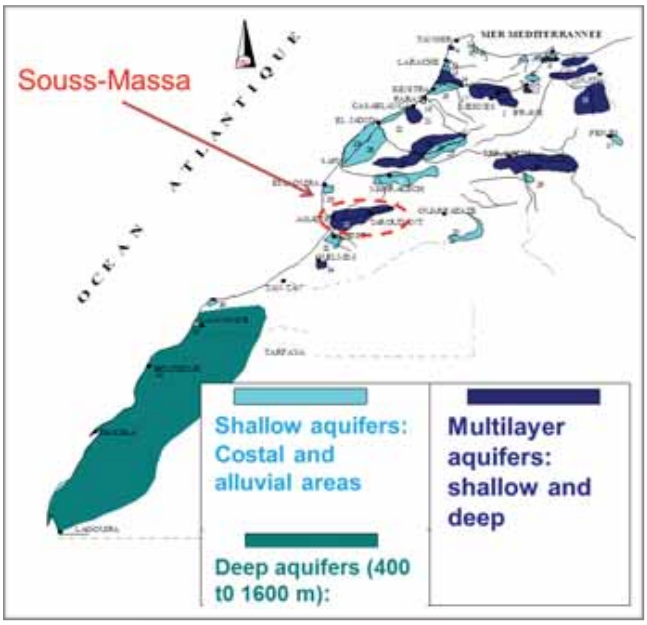
Lhoussaine Bouchaou

Mr. Bouchaou presented some applications of MAR techniques in Morocco and talked about two successful case studies of climate change adaptation. His presentation was divided in two parts:

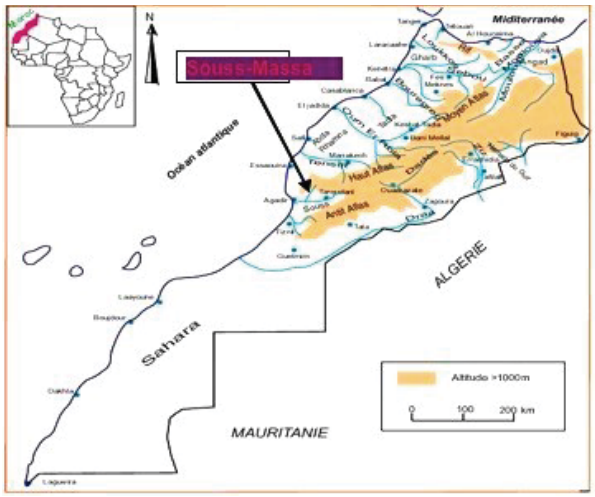
1. Overview of water resources in Morocco, and
2. Two case studies of overexploited aquifers.

He first showed a map indicating the high values of groundwater abstraction rate in the MENA region as a percentage of the recharge, demonstrating that aquifers are generally over exploited. In Morocco about 80 aquifers were identified. The water crisis in Morocco is mostly due to low precipitation and over exploitation. At the same time floods and droughts are frequent. Too often water agencies tend to focus on development rather than on the wise governance of the resource. There is a need to look for the root causes of aquifer degradation. A project was suggested to transfer water from the North to the South.

The Souss-Massa aquifer is one of the more important aquifers in the south of Morocco, where 80% of vegetables and fruits are produced.



This region is economically important for the country in terms of agriculture, tourism and maritime fishing. Approximately 94% of water resources are used for irrigation. Different studies have investigated issues of groundwater salinisation and recharge, and the evaluation of the residence time of water into the aquifer.



The root causes of degradation of this aquifer are:

- inefficient groundwater resources governance by the responsible public agencies, which have focused more on development than on management
- low public and political awareness, as many still consider groundwater as an unlimited and independent water resource
- a lack of appreciation of critical linkages with the 'surface environment' and land-use practices.

As a consequence, groundwater in coastal and inland aquifers is threatened by variable degrees of salinisation and deterioration in groundwater quality in more than half of the aquifer. Even in recently irrigated perimeters, pollution by nitrates has been observed and a shift of the recharge zone to the east, due to over exploitation of groundwater resources. Pumping rates higher than the rate of recharge have led to a groundwater deficit and unsustainable use, despite the fact that small dams may stock significant amounts of water and provide flooding regulation. At the same time, there is a risk of desertification caused by low and irregular in time distribution of rainfall, and frequent, long lasting periods of droughts. Using environmental tracers the variable origins of water and salinity have been investigated, in order to better understand the functioning of the Souss Massa aquifer.

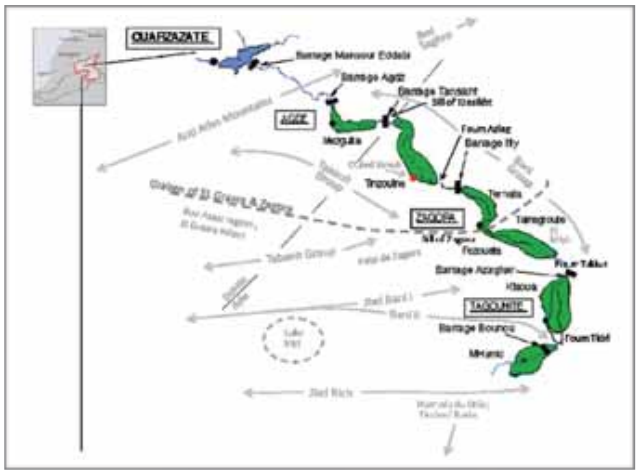
Conclusion: Chemical and isotopic tracers are tools that can facilitate research on the origin of groundwater resources particularly in arid areas, coastal aquifers and non-equipped zones. Groundwater salinisation may have occurred for different reasons, such as dissolution of evaporates; sea intrusion and return of irrigation water. MAR could be a good solution for enhancing groundwater resources and reducing salinisation.

The case of the Draa Basin

Agricultural production and water supply for domestic use and ecosystems in semi-arid climates are subjected to various constraints, such as:

- domestic and agricultural water needs
- availability of surface water and sufficient GW recharge
- availability of GWR
- different requirements for crop production, apart from water
- salinity of the soil.

The main objective is to develop a fully integrated water resources management (IWRM) plan combining a land management approach, adapted



to preserving sensitive ecosystems. In order to achieve this objective, various activities are necessary, as follows: increase knowledge of GW resources, ensure the socio-economic development of the area and related GW needs and analyse the irrigated agricultural production systems. IWRM is the general framework composed of:

- a multi-disciplinary approach: managing people, and adopting a socio-economic, legal, institutional as well as technical and environmental approach
- a cross-sectoral vision: macro and micro level, urban infrastructure design and operation, agriculture cropping policy and practice.

Ebel Smidt

Mr. Smidt presented a paper entitled: "MAR as linking pin between land and water management".

The main messages he put across were:

1. Groundwater buffering is an ancient answer to water crises
2. Groundwater is a natural buffer that should be used wisely
3. After 60 years of international experience, MAR offers opportunities for future cooperation in applied and research projects.

For fresh groundwater, storage and flow time are important parameters.
Multiple benefits may come from MAR, such as:

- storing water for future use
- stabilising or recovering groundwater levels in over exploited aquifers
- reducing evaporative losses
- managing saline intrusion or land subsidence, and
- enabling reuse of waste or storm water

Case 1. History of Managed Aquifer Recharge (MAR) and Storage (MARS) in the Amsterdam Dune Area

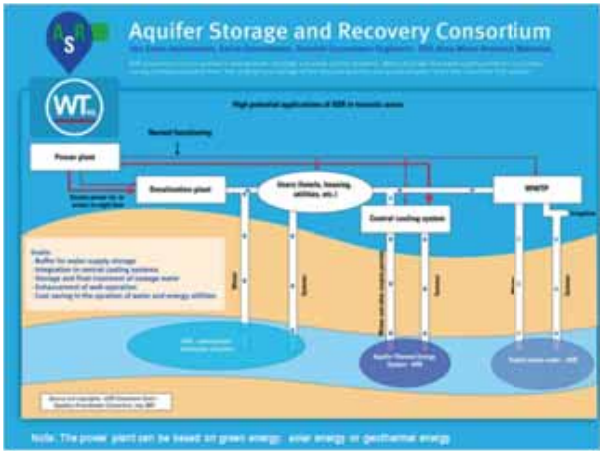
In order to be able to extract drinking water from the dunes aquifer, artificial recharge prevented and pushed back salt-water intrusion. Combining coastal protection with groundwater management is the way forward for the future.

Natural and man-made buffers, such as MAR and Recharge, Retention, and Reuse (3R) may be realised using different techniques including the following: rainwater harvesting, runoff harvesting, riverbank infiltration, channel modification, sand dams, infiltration ponds, well shaft and borehole recharge, and qanats. In order to decide on the best technique to use, different criteria should be considered, such as physical requirements, the expected benefits and the available investments.

Case 2. Desalination of Sea Water (DESAL-MAR)

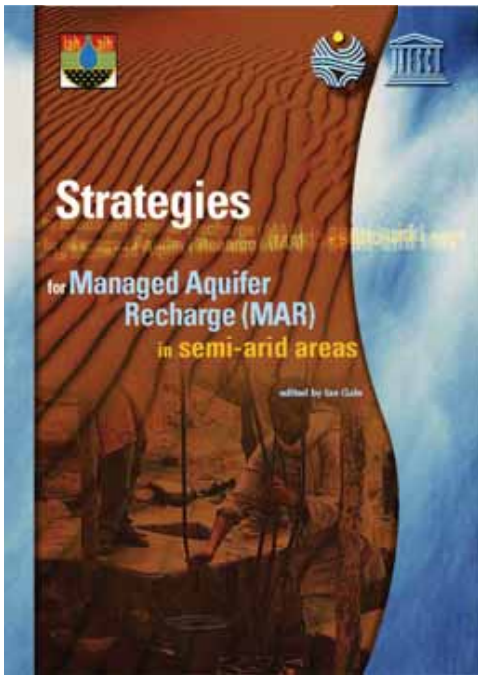
The option of combining desalinated water with wastewater reuse seems to be very promising. In this perspective, the economics of combining the Aquifer Storage Recovery System (ASR) and desalination should be investigated.

The main challenge is to apply effective groundwater governance in a changing world and as the French philosopher Paul Valery (1871 - 1945) said: "The trouble with our times is that the future is not what it used to be". The role of UNESCO's International Groundwater Resources Assessment Centre (IGRAC) is to develop and maintain one of the main Internet portals for disseminating groundwater knowledge (www.un-igrac.org).



Some closing remarks:

- It is not always feasible to use conventional water resources to supply rural communities
- Water shortages can, for a large part, be solved by storing excess water during wet seasons and making it available during dry seasons
- Water storage in the subsurface has many advantages over surface water storage
- Everybody has the right to assess the groundwater buffer
- Cheap and simple methods can be used for implementing it.



DISCUSSION BOX
Two comments were made:

- Local agricultural practices can also contribute to groundwater recharge, although great importance has been given so far to large infrastructure.
- Some important questions: (i) how can we benefit from pluvial agriculture? (ii) How can evapotranspiration and evaporation be decreased? Because water scarcity is a global issue we should not limit ourselves only to MAR.

Further remarks:

- A crucial problem is the diffuse pollution from fertilisers and nitrates. What can we do for those aquifers that are already polluted? What are the best practices?
- Dam recharge is good, but we should not forget the ecosystems services. The MAR techniques should not forget the role of the ecological surface and groundwater flow
- We can recharge an aquifer using desalinated water, but it's very expensive and requires a lot of energy. Desalination is for potable water and to provide some relief to natural water resources.
- Water scarcity is mainly due to an increase in demand. Data show that the decrease in precipitation is not so great.
- We need to think about basin scale resource management in order to adapt to CC. We have to study best agricultural practices, and we need to gather stakeholders together in order to achieve better water management. There are already solutions for implementing drip irrigation
- The fact that water does not reach the ocean is an important environmental issue that needs further research.

Tobias El-Fahem

Mr. El-Fahem presented the topic of "Managed Aquifer Recharge (MAR) in Jordan". The presentation was prepared in cooperation with Anke Steinel. The results refer to a study jointly conducted by The German Federal Institute for Geosciences and Natural Resources (BGR) and the Ministry of Water and Irrigation (MWI) of Jordan. Mr. El-Fahem presented the newly released report on "Guidelines for

assessment and implementation of MAR in (semi)-arid regions".

He firstly gave an overview of the current situation as follows:

- Over abstraction of GW-resources leading to a decline in the GW-table
- Increase in demand due to population growth
- High evaporation during surface storage
- Sporadic flash floods 'unused'

He then reminded participants about the rationale for the use of MAR:

- Increase of GW-resources
- Raise the GW table
- Dilution of GW with rising salinity

The objectives of this study commissioned by the MWI were:

- Exemplary development of a map for MAR potential in the Amman-Zarqa (AMZ) and Azraq basins
- Subsequent identification of potentially suitable MAR sites
- Preparation of guidelines for the implementation of MAR in arid and semi-arid regions

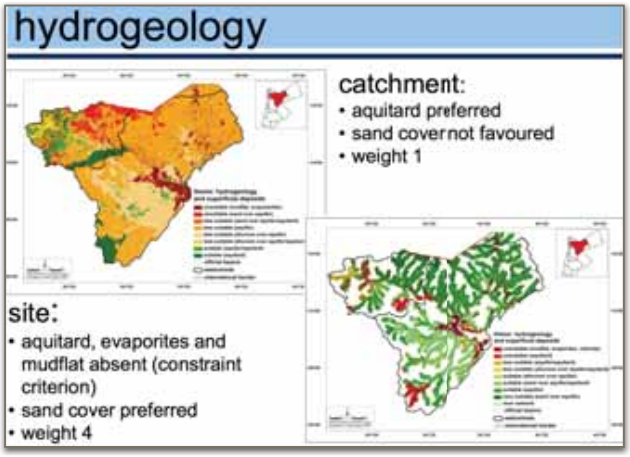
The study was divided in 4 stages: pre-feasibility, feasibility, implementation, and operation.

Pre-feasibility stage:
- Determine water demand and state characteristics
- Collect available data
- Resources evaluation at potential MAR sites

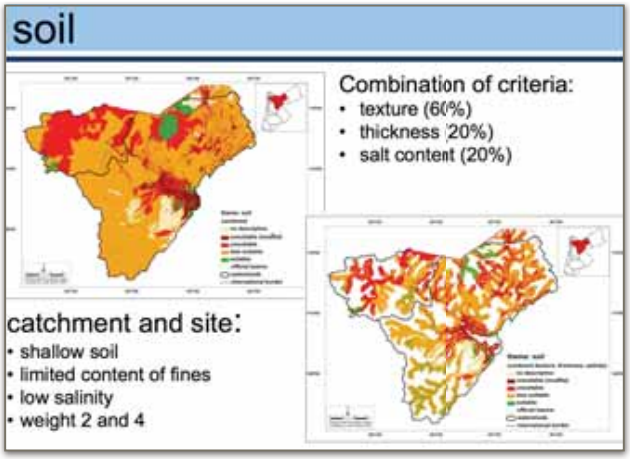
Feasibility stage:
- Site specific studies (conceptual hydrogeological model)
- Planning: conceptual, operation and management (O&M), contingency plans
- Impact assessment (environmental, social, legal)
- Cost-benefit analysis

Implementation stage:
- Obtain the required licenses
- Construction, including a monitoring system

Operation stage:
- Operations and maintenance (O&M) including training of operators, monitoring, record keeping
- Revise the procedures based on actual performance.
- Focus on 3 techniques: infiltration dam; recharge release dam; infiltration basin.



Six indicators for the assessment of catchments, and 17 indicators for the assessment of the suitability of sites were used. Runoff measurements were available for different sites (AMZ, Azraq). Runoff, as well as water quality measurements, is subject to different uncertainties. Precipitation was one of the most important indicators, since runoff quantity and quality were not reliable enough. Other factors included: evaporation, land-use, rainfall intensity, soil characteristics, topography, hydrogeology, types of land-use and aquifer thickness. One of the conclusions was that costs were underestimated and benefits overestimated.



Some recommendations:

Technical:
- Rehabilitation and retrofitting existing dams
- Monitoring of effectiveness of existing dams
- Monitoring of runoff quantity and quality before implementation

Socio-economic:
- Development of national MAR strategy
- Clear definition of objectives
- Increase of management capacity with a new organisational unit
- Involvement of local stakeholders and transfer of responsibility to local beneficiaries

Elias Salameh

Mr. Salameh highlighted the importance of implementing water storage during the winter. He mentioned some mandatory conditions for launching groundwater programmes and the necessity to use the Jordan valley to store excess water by using artificial groundwater recharge.

Hesham Al Hesa

Mr. Al Hesa gave an extensive presentation on the Wala Dam, which was the site visited during the field trip on 12 December 2012(*).

MAR is used here for implementing Integrated Water Resource Management (IWRM). The Wala Dam was constructed in order to collect floodwater and recharge it into the underlying limestone aquifer, from where it is reclaimed at the Heidan well field for drinking water supply.

(*) More details on this presentation are reported in the section related to the field trip.

I.3 Practical working session – role play

Role plays were conducted by Ebel Smidt in cooperation with Lhoussaine Bouchaou.

Ebel Smidt prepared a practical exercise to illustrate how to apply MAR strategies in specific contexts, taking into account political, economic,

technical and scientific considerations. Participants were divided in two groups and each was assigned a fictitious case to work on. One was on “MAR and IWRM in a coastal area” and the other on “MAR and IWRM in a transboundary river” (both exercises are annexed to this report). The two groups actively engaged in this role-play and prepared suitable plans to resolve the cases. After the break out session the two groups reported on the strategies adopted as well as on the difficulties and challenges encountered during the negotiations.

II. FIELD TRIP TO THE WALA DAM - Day 2

Eng. Al-Hesa from the Ministry of Water and Irrigation, Jordan Valley Authority, first summarised the situation concerning water resources availability and management in Jordan. He then provided more information about the Wala Dam.

The country's climate is semi arid and apart from the Jordan valley, surface water resources are scarce. This means that groundwater aquifer resources are a very important source for drinking and irrigation, especially during periods of drought.

The country extends over an area of 89.400 km^2, of which more than 90% is desert. The population is about 6 million, with a strong population growth of 2.84% annually.

In the desert area, which covers the majority of the country, mean annual precipitation varies between 50 and 200 mm. Precipitation is more important in the Jordan Valley and in high land, where it varies between 400 and 580mm/year. In Millions of Cubic Meters (MCM) the water availability in the country varies from 5.800 in dry years to 11.000 in wet years with 8.300 on average. Hydrographic maps of 15 river basins, mainly ephemeral, and the location of 12 main aquifers were shown, together with the water potential of each one in MCM. Jordan has invested in the construction of several dams and water reservoirs, and more specific information was provided for the Wala Dam, which was visited during the field trip.

Al Wala dam is located about 40 km south of Amman City at Wadi Al Wala, near Kings Highway. The dam is 45 m high and 480 m long: its construction started in 1999 and was completed in 2002. The total capacity of the dam is about 9 MCM, the water being used mainly for irrigation, water supply and recharge.

It is interesting to note that the dam is equipped with a bottom outlet for sediment flushing and that it was constructed to collect floodwater and recharge it into the underlying limestone aquifer, where it is reclaimed for drinking water supply at the Heidan well field.

The replenishment of the aquifer is documented by monitoring the groundwater level of the Heidan well field. The mean annual abstraction (2002-2011) is around 11,86 MCM, mostly used for drinking water supply.

The main positive environmental impacts of the dam are:

- Improving the water quality at Wadi Al Hiddanand and at the dam reservoir
- Restoring the wildlife and vegetation downstream
- Improving the biotic ecosystems of the region.







III. MAR Experiences - Day 3

On the third day of the workshop GEF MENARID Project Managers were asked to present their projects, focusing particularly on groundwater resources management and the current or potential applications of MAR activities, if any. In case no such activities were yet taking place, presentations were to focus on how MAR strategies could be applied in the future within the framework of their projects. The main points highlighted in the presentations are summarised below. Further details can be found in the full versions of the presentations, which are annexed to this report.

Experts from ICARDA and the Ministry of Water and Irrigation of Jordan delivered presentations on (1) "The limits of Groundwater Mining in Dry Areas" and (2) "Nuclear Techniques Applications for Determination Artificial Recharge Efficiency in Jordan" respectively. Some wrap-up remarks were prepared by Ebel Smidt, Lhoussaine Bouchaou and Holger Treidel.

The day concluded with a presentation from ICARDA IT specialists on the new MENARID platform (a first brainstorm on the features needed for this common platform was held during the Programmatic Workshop for MENARID that took place in Rabat in June 2012).

III.1 Presentations of MENARID Project Managers on MAR

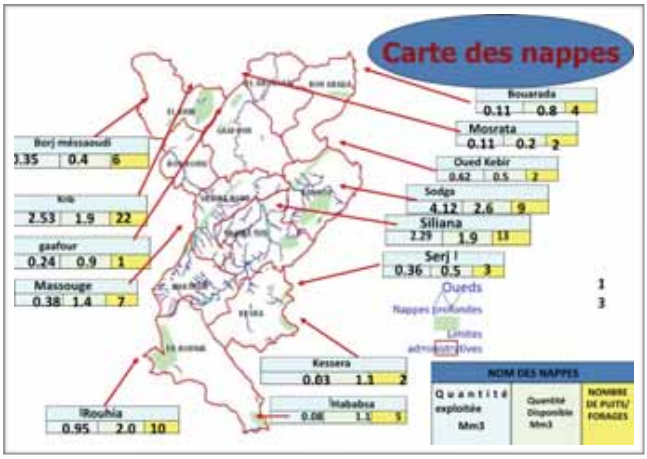
Hichem Lakhdhar

Mr. Lakhdhar presented a paper entitled: "Workshop on learning and sharing knowledge and know-how on water resources management in the areas of the FEM project, Siliana region, Tunisia". He started with an overview of water resources management in the Siliana region and spoke about the main challenges in terms of the project. Desertification and drought, together with uneven repartition of rainfall in time/space, have been highlighted as being among the principal problems in the region and the cause of significant water deficit and degradation.

Agriculture is the main activity in Siliana with 20.000ha of irrigated land. Mr. Lakhadhar stressed the importance of groundwater for irrigation and the need to diversify agricultural and economic activities to alleviate the pressure on scarce water resources.

	Pourcentage %	Quantité d'eau (Mm 3)		
		mobilisée	mobilisable	potentiel
Les eaux de surface	91	121.0	133.0	182.0
Phréatique	67	9.9	14.7	14.7
profondes	64	14.9	23.3	23.3
Eau traitée	33	0.3	0.9	2.0
Total général	**84**	**146.1**	**171.9**	**222**

As a consequence of erosion and augmentation of salinity in the water, the poverty rate and exodus of people to urban areas are increasing in the region. This situation needs to be fought against, whilst at the same time natural resources need to be preserved by implementing strategies against erosion, improving water infiltration and mobilising surface waters (cisterns, irrigated perimeters, etc).



There are several small aquifers in the region with great potential.

Among the strategies for soil protection and the fight against erosion, aquifer recharge is already being taken into account.

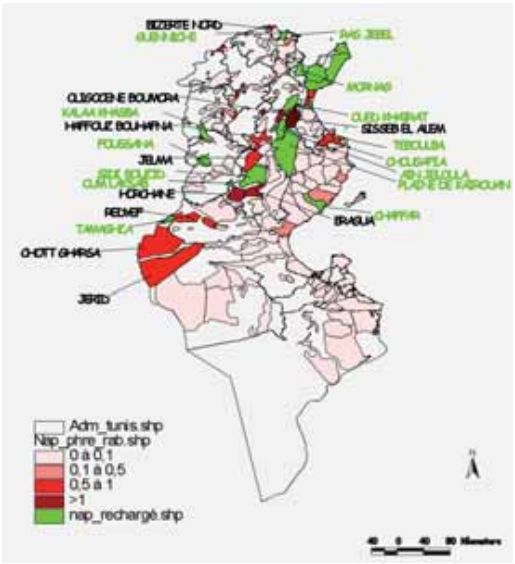
Mr. Lakhdhar also mentioned achievements such as a hill reservoir, a water treatment plant, an oil extraction project, bank fixing by planting cacti and subsidies for drip irrigation.

Awatef MESSAI

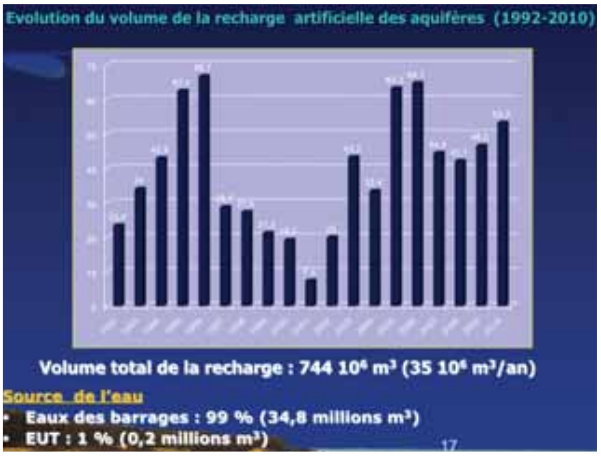
Ms. Messai gave a presentation entitled "Artificial recharge of aquifers in Tunisia: A case study with technic-economic and environmental feasibility study of artificial recharge in 8 phreatic aquifers". The Tunisian experience in MAR is based on multiple experiments by applying different recharge techniques in several regions of the country.

First, a general overview was given on water resources management in Tunisia, where ¾ of the territory is arid. There is a high climatic variability, which requires management of extremes, for example 1 year out of 3 is very humid or dry. Several challenges affect groundwater resources, such as over exploitation, pollution, frequent scarcity of precipitation, aridity and impacts of climate change. Currently there are 23 aquifers that use recharge at 55 sites.

Aquifer recharge has both positive and negative impacts. In the next 20 years the total volume of artificial recharge will reach 744 Mm^3 (35 Mm^3/yr - including recharge with treated waste water).



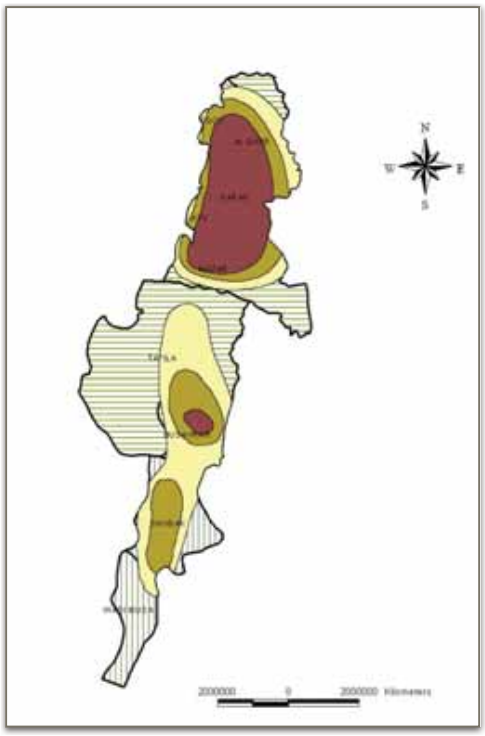
Treated wastewater accounts for only 0.1% of recharge, because there is a general reticence by farmers to stock EUT (Treated Waste Water) as they believe that the water is not clean. Also it is not possible to pray in fields irrigated with EUT.



A communication strategy is in place to address these concerns. Ms. Messai reported on the main conclusions from the project presented. In answer to a question, she admitted the relatively high cost of the treatment unit (around 2 to 3 €/m^3). She also said that it would be possible to reproduce such a project, and said she has all the technical details necessary for implementation.

Mamoon AL ADAILEH

Mr. Al Adaileh gave a presentation of the project component related to sustainable water/land management. He gave an overview of a project which has been implemented in the southern highlands of Jordan, at the governorates of Karak, Tafila and Ma'an through five field units. The aim of the project is to prepare Community Action Plans (CAP).



The main objectives of the project are to improve food and water security, and the income levels of the target group of poor and rural households residing in the project area, by promoting the effective use of soil and water resources, and by introducing better management practices for their sustainable use.

This can be achieved by: (i) providing technical and financial support to construct soil and water conservation measures and improve agricultural production through active community participation; (ii) promoting sustainable land management practices; (iii) Promoting rural micro-finance for on- and off-farm activities, and ;(iv) strengthening the capacity of the existing Project Management Unit (PMU) and the agricultural directorates in the project area.

Some of the main achievements of this project component included: training farmers for capacity building on water use and management; grey water units to increase farmers' awareness at a household level about reusing grey water (the project provided support for the installation of 15 units); water harvesting using a VALIRANY machine to reduce soil erosion.

Water resources development includes:

1. Construction of on-farm storage facilities;
2. Off-farm reservoirs (mini earth dams) for seasonal storage of water;

3. Protection of the springs and rehabilitation of their irrigation systems;
4. Assisting and training water users to form Water Users' Associations (WUAs);
5. Feasible treatment of households' domestic grey water for reuse.

Also an important measure for combating land erosion has been the protection of the Wadi Bank with canal rehabilitation. This has had many benefits, such as easy access to the water resource; an increase in water uptake from the

spring; an 85% reduction in water loss thanks to canal maintenance; and an increase in the amount of water that actually reaches the farm.

El Hassane REJMIL

Mr Rejmil gave a presentation of the project: "Saving the Figuig Palm Grove, South East of Morocco". The Figuig Circle is an arid region in the South-East of the country. It is divided into two parts: the pastoral zone (need for potable water) and the oasis zone (need for water to irrigate the palm grove). In the pastoral zone there are a number of initiatives to alleviate the pressure on the aquifer, such as dams and water harvesting practices.

In the oasis zone there is a problem of salinity in the water pumped from the wells in the palm grove; a deficiency of 40% of water for agriculture; abandoned land; lots of wells being dug; and a pull back of the nappe. A number of solutions have been identified within the project, including the creation of a local water council to sensitize farmers to new techniques optimizing water use (goutte à goutte). Water governance is very important. In particular the rehabilitation of the ancient irrigation system has been put in place.

Currently the project is undertaking a study on the characterization of the phreatic table. One of the essential points of the project is the sensitization of local and agricultural populations through water tarifing/pricing.

Conclusion: the aquifer recharge should be everybody's concern and should be achieved using a variety of means: 1) through direct and conventional interventions (natural and artificial recharge); 2) through alleviation of the resource by minimising anarchic pumping; 3) through practices and techniques aimed at optimizing surface water resources; 4) through the sensitization and direct involvement of users (farmers and citizens).

DISCUSSION BOX

Questions: Is there any national water council? What is the composition of the local water council? Are there any conflicts of interest?

Responses: 8 associations are active in the palm grove: they form the local authority that is the water council. At a national level, an administrative body delivers authorisations for drilling of new wells. The local council is not a substitute for the national one. Sometimes farmers drill new wells without any formal authorization. It is therefore necessary to create a more responsible local council in order to involve farmers in the decision making process.

Abderrahim BOUTALEB

Mr. Boutaleb gave a presentation entitled: "Techniques of integrated water resources management for combating desertification in the high Eastern plateau". His presentation was divided into two parts: first, he overviewed the MENARID project and second, he focused on IWRM techniques that have been adopted in order to fight desertification in the area of the « Hautes Plateaux de la Region Orientale ».

The objective of the project was to reduce poverty and protect the environment in the high plateaus of the Eastern area. The IWRM techniques that have been adopted are the following: small dams, rainwater harvesting and soil conservation using the Vallerani System (SV). This is an interesting technique for fighting desertification (see detailed information in the presentation).

Tractor drivers were trained to be able to maintain the tools that are used to work the soil. Partnerships with local cooperatives are foreseeable.

Lamia JEMELLI

Ms. Jemelli gave a presentation on the "Project for Natural Resources Management in Tunisia-phase II (PGRN2)". The mobilisation of surface and groundwater resources has always been a priority in development programmes at a regional level. This mobilisation was included in different national strategies characterised by a rational planning of the realization of hydraulic structures (dams, lakes, wells, springs, etc). There is a willingness to involve the Groups of Agricultural Development (GDA) in water management and tarification.

Two examples illustrating the role of the PGRN2 project for the preservation of aquifers are reforestation for groundwater resources protection and control of soil erosion. Another example is the reduction of pollution in the aquifers thanks to awareness raising and the sensitisation of farmers, as well as through investments aimed at diminishing pollution generated by the agricultural sector. These activities are in line with the objectives of sanitation and wastewater treatment (Collaboration with the Ministry of the Environment for wastewater treatment).

Another important aspect is to ensure synergies with other programmes and projects, such as the Land Degradation Assessment in Drylands programme(LADA), supported by the Food and Agricultural Organisation of the United Nations

(FAO) and the United Nations Environment Programme (UNEP) with the aim of reducing soil loss.

Hedi HAMROUNI

Mr. Hamrouni gave an overview of the LADA project in Tunisia. Good agricultural practices contribute to the recharge of aquifers. There is an inventory of best agricultural practices being carried out by FAO in Tunisia, based on the WOCAT method.

In Tunisia there are several practices for the management and conservation of water and soil. Among the most relevant are:

- The « jessours »: system of utilisation of runoff waters.

- The « tabias»: system of runoff water collect in flat sites

- The «meskats»: system for the utilisation of runoff waters in the Tunisian Sahel

- Valorisation of floodwaters using the « mgouds » technique

DISCUSSION BOX

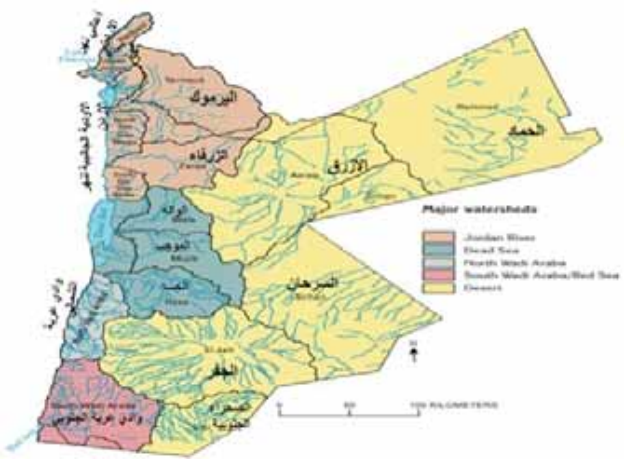
Question: Why were the « meskats » abandoned? Is it because this practice is old or because more efficient methods have been found?

Answer: This is not because of the technique but because agricultural activities have been abandoned in favour of urbanisation and because of socio-economic changes.

III.2 Presentations from other experts

Mohammad MOMANI

Mr. Momani gave a presentation entitled: "Nuclear Techniques Application for Determination of Groundwater Artificial Recharge Efficiency in Jordan" (joint preparation with Eng Ali Subah). In this presentation, the groundwater situation in Jordan, which is an arid and water scarce area, was described and the role of artificial recharge for groundwater sustainability was highlighted.



The role and importance of nuclear techniques in groundwater resources protection and management were emphasised and recommendations in order to maximize the effectiveness of using groundwater artificial recharge were provided.

In Jordan two aquifer types can be distinguished:

- *Bedrock aquifers* (sandstone aquifers; carbonate aquifers; and Basalt aquifers)
- *Unconsolidated aquifers*

Isotope Hydrology is a performing tool in water resources studies and investigations : It is a nuclear technique that uses both stable and radioactive environmental isotopes to trace the movements of water in the hydrological cycle. Isotopes are atoms of the same element that are chemically identical, but physically different. They can be measured and quantified using mass spectrometers and alpha beta counters.

Some conclusions and recommendations follow:

- Artificial recharge to the groundwater is governed by several hydrogeological factors that control the movement and the dissipation of the recharged water in the subsurface.
- The recharge potential is reduced in cases where very fine sediments prevent rapid infiltration and groundwater recharge.
- The radioactive tritium and the stable isotopes of δ 18O and deuterium could improve the groundwater replenishment through artificial recharge.
- There was significant groundwater recharge potential at the beginning of the dam's operation, this could also be supported by the groundwater level monitoring wells.
- The protection of the groundwater artificial recharge and surface water harvesting schemes from sediments is a major issue to be considered in the design and evaluation of MAR schemes.
- It is recommended that a knowledge management strategy be developed and implemented in MENA countries to protect land, soil and water. This strategy should be integrated into strategies for environmental sustainability as well as for water resources management, including Management Aquifer Recharge (MAR).

DISCUSSION BOX

Question: Fertilisers may produce groundwater nitrification. What are the alternatives? How could farmers be persuaded to reduce their use of fertilisers, when they want to increase soil fertility and agricultural production?

Answer: Integrated land management is mandatory. Research, education and development agencies have to advise farmers to reduce their use of fertilisers. Groundwater protection has started to be implemented in areas where there is a risk of pollution through agriculture. The task is difficult.

Aden AW-HASSAN and Roberto TELLERIA

This presentation highlighted the limitations of the excessive use of groundwater for irrigation in dry areas. The study concerns the economic costs and benefits from intensive agricultural production in a region near the city of Aleppo in Northern Syria.

In order to achieve food security and reduce the import of cereals, an ambitious governmental programme was implemented in Syria during the period 1960-2009. The objective was not only to limit the import of cereals but also to produce sufficient quantities of cereal for export.

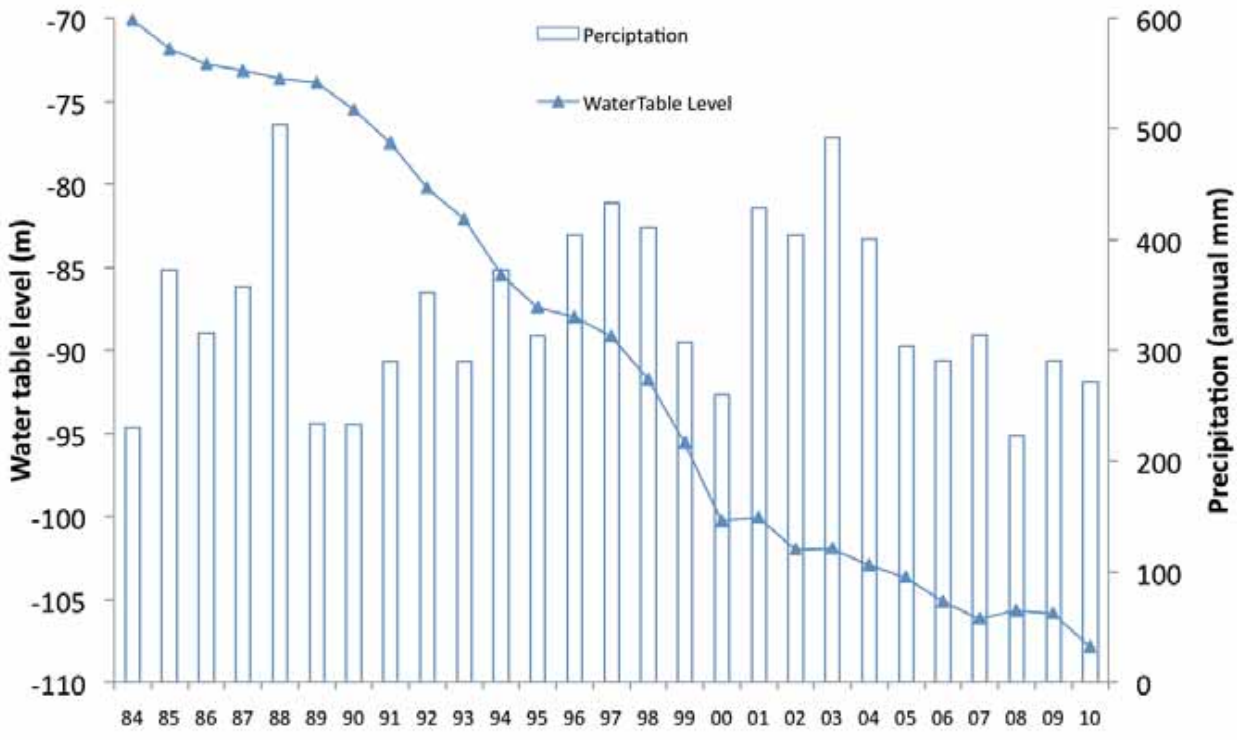
The planning took place in 3 stages: the 1st between 1960-and 1984, the 2nd between 1984 and 2000 and the 3rd from 2000 to 2009.

During the 2nd period an intensive programme of different subventions was implemented: wheat and cotton prices were guaranteed and direct input subsidies were granted to farmers (seeds, fertilisers, farm equipment and fuel), which reduced their costs by about 50%. At the same time, new well licensing was facilitated.

About 70% of the total agricultural budget was subsidised. As a consequence, since 1990 there has been a big increase in the total irrigated area and in the number of wells for groundwater irrigation. This non sustainable situation presented the first inflexion point in around 2005: although precipitation had not shown any particular trend, the groundwater table declined drastically at an average rate of 1.5m per year, as shown in the graph based on data collected by ICARDA during the period 1984-2010.

Although new wells were drilled without any control, the agricultural production decreased because the level of the water table decreased and insufficient water was available for irrigation. In economic terms the agricultural profit may be deduced from the Marginal Physical Product Benefit minus the Marginal Irrigation Cost (MIC) This means that if the subsidies are removed, farming is no longer profitable.

This result concerns wheat and cotton. Some other commodities may survive without subsidies (mostly vegetables). In any case a sustainable policy should produce positive results in the long term.



DISCUSSION BOX

Remarks: Subsidies may destroy agriculture and benefit rich rather than poor farmers. Another consequence is the negative environmental impacts.

Control of well drillings is an issue. The use of groundwater for irrigation is important, but a balance has to be maintained between recharge and pumping. Economic instruments can help to regulate groundwater use and facilitate appropriate groundwater management.

Question: the real problem is not the subsidies aiming only to increase production, but the lack of a long term strategy. Is it necessary to diversify agricultural subsidies and to follow up the consequences?

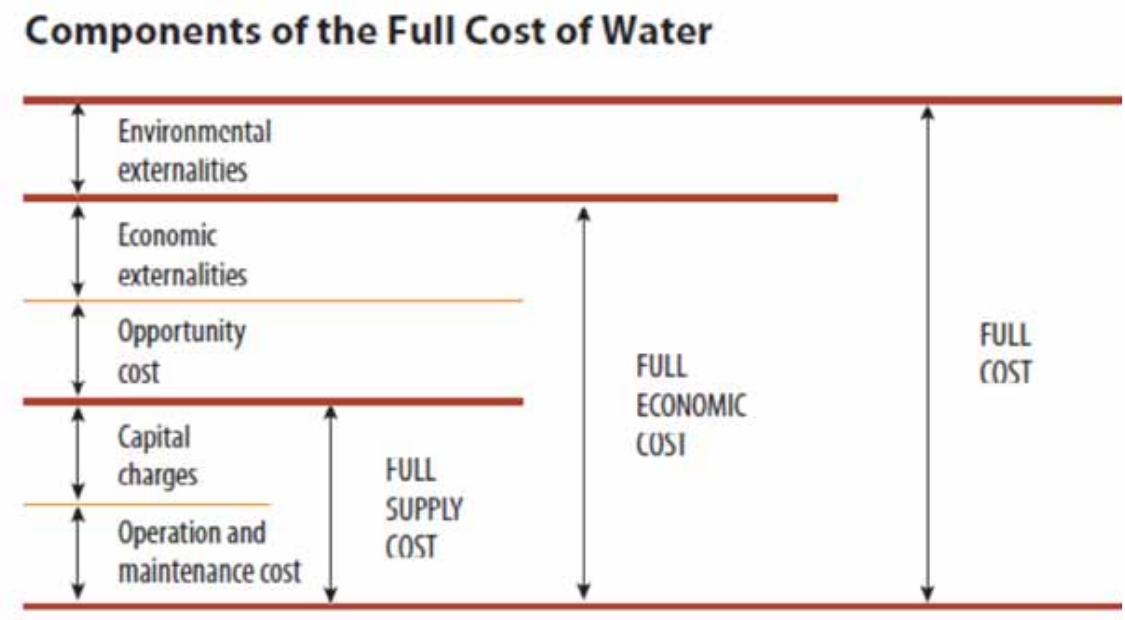
Answer: Syria achieved significant progress, but no balance between production and sustainability was achieved. The problem is not the lack of strategy but rather the lack of sustainability of the strategy. This presentation does not pretend to show that subventions are bad, although they could be bad if they are not used in a proper way. Proper water tarification may help achieve an equilibrium.

III.3 Wrap up

Ebel SMIDT

Main messages:

1. Buffering and changes in land use are ancient answers to crises. Important are also behavioural changes!
2. Groundwater is increasingly being used wisely as a buffer, as can be seen from various. MAR-Menarid examples.
3. A lot of work still has to be done concerning both downscaling and upscaling of MAR-implementation.
4. Opportunities, such as this event, for exchanges are an excellent tool to enhance future cooperation and to exchange practical results and research experiences.
5. MAR-technology is already well developed and will be further developed to combine conventional and modern methods. General guidelines are available and are being updated. Improved effective and efficient exchange mechanisms on national and international levels are needed, especially concerning societal acceptance or integration of MAR.



6. The main scientific questions focus on (a) water quality issues, (b) optimisation of water balancing, (c) planning and monitoring and (d) integration of technical, socio-economic, institutional and participation issues (=governance). Tailor-made solutions are needed within generic frameworks.
7. Downscaling means bringing practical solutions to the lowest levels in a watershed (individual plants, trees and people), upscaling to the highest levels of the watershed (transboundary if needed). Integration of the two processes is an important challenge to increase the speed of success.
8. Cost effectiveness and cost recovery are important issues: especially in groundwater/ MAR-issues full cost analysis (including long term development / sustainability issues) is needed.
9. The Sept 2014 Marrakech IAH conference is a good forum to present the results of the down- and upscaled processes following this workshop (www.IAH2014.org).

After-thoughts:

- dissemination of workshop results to other interested countries (Egypt, Palestine, Irak, Lebanon, maybe also the Gulf countries, due to the experiences in Abu Dhabi with MAR their involvement could be considered)
- make this workshop output orientated: aimed at project formulation and financial engineering
- organise an in depth training on MAR for specialists (there is much more to do than just the geophysical methods that were suggested): the design of such a workshop could be tailored to the specialists within the projects
- assist Jordan & Palestine especially (and maybe in cooperation with Egypt and Lebanon) to formulate a joint project on MAR
- support a special session at the IAH conference in Marrakech 2014
- think about letting IGRAC make a special window on MAR experiences worldwide

Lhousshaine BOUCHAOU

In his presentation Mr. Bouchaou firstly gave an overview on water resources in Morocco and secondly he described in detail the experience from artificial recharge in 2 case studies of over exploited aquifers.

The water resources distribution in Morocco is unequal both in time and space. 60% of water resources are available in the North with only 11% in the South. Water scarcity, due to the arid and semi-arid climate and water overuse, means there is a scene of water crisis in Morocco.
A large part of water, up to 90-96%, is used for irrigation. Groundwater resources in Morocco are very important sources of fresh water. About 80 major aquifers were identified, 48 unconfined and 32 confined. However, the available water per capita is steadily declining: from 2560 m^3/capita/yr in 1960 to 720 m^3/capita/yr currently and to 520 m^3/capita/yr predicted by the year 2020.
Also the decline of the water table in several major aquifers is particularly alarming. A major problem is the increase of water salinity and the pollution of groundwater from fertilisers and pesticides. On top of that, climate change has induced frequent droughts and floods. Since 1950 more than 40 periods have been recorded and floods have been devastating in urban areas.
One of the main elements in the new strategy for water resources management in the country is the use of Managed Artificial Recharge (MAR). Despite the remarkable role MAR can play in sustaining groundwater potential, it has many technical problems, as for example in karstic aquifers, where water speed is high.
A detailed hydrogeological study, including isotopic analysis, has been conducted in the Souss-Massa aquifer. In this case MAR techniques have proved very useful in increasing agricultural production.

As a general conclusion Integrated Water Resources Management (IWRM) based on multidisciplinary contributions and cross-sectoral visions should be adopted in order to improve the current situation.

Djamel LATRECH

Main issues:

- Agricultural activities should be emphasised as they use the majority of groundwater. New technologies and renewable energies, like solar energy, could reduce the exploitation cost of aquifers already salinised. Examples from Tunisia.
- Soil salinisation is an important issue.
- The economic dimension of rehabilitating the traditional methods of groundwater recharge should be considered under changing socio-economic conditions (older population of farmers, loss of knowledge, urbanisation).

Discussion:

- MAR technologies have already been presented and need to be further studied.
- An effort should be made to develop effective monitoring methods that could be based on GIS.
- The selection of crops that are resistant to salinity is also an important topic.
- It is necessary to promote a participatory approach for managing groundwater resources.
- Interaction between subsidies and water management
- MAR technologies have been sufficiently developed and should be adapted at different scales
- Optimal land use, supporting policies
- Participation was not included in the development
- Need for a global diagnostic (technical, environmental, economic, social)

III.4 MENARID web platform

Background: IFAD is required to develop and implement a web platform for MENARID based on SharePoint.

Key: collaborate and share information; management and sharing.

Platform goals: facilitate daily work, public part where you can promote your projects => study replication. Importance of collaboration.

DISCUSSION BOX

- There is a need to focus on practical applications. The point of getting together is to share knowledge
- We need to have an incentive to share and show the successful stories
- How can we facilitate cooperation?
- Possible translation of website in Arabic/French?
- Is there the possibility of sending an email to other participants when a new document is uploaded?
- Creating a user manual for the site
- Possible 1-2 day workshop next year.
- Use of videoconference possible.
- We have to define more precisely what kind of information we want to communicate
- We should communicate with decision makers and suggest a common methodology
- Based on in-situ knowledge, we should better define various themes.

IV. MENARID Planning Meeting for 2013 - Day 4

IV.1 Documents on the MENARID platform

Dr. Aden Aw-Hassan introduced Mr. Hugo Remaury as the new Project Coordinator. He also introduced the new MENARID platform and emphasised the importance of using it. Dr. Aden Aw-Hassan highlighted that the platform is now fully operational and has a facilitator. This will benefit all users. He then stressed the idea that Project Managers should start populating the website with information about their own projects. This information can be of any type, including project briefs (objective, partners and achievements), innovations, good practices, technologies, life cycle, background studies, logical frameworks, results (case studies, synthesis, reports) or other documents that are already available, and that Project Managers would like to share on the MENARID website. A consistent layout should be used in order to show similarities between projects.

Mr. Latrech said that each GEF project has its own logic, and that there is a need to synthesise information for each of them. However, other documents are also necessary.

Mr. Lakhdhar expressed a wish to have detailed information online, along with information on issues faced by farmers themselves. He also mentioned that it is necessary for information on monitoring and evaluation to be available online.

Dr. Roberto Telleria said that documents about groundwater could be uploaded online.

Mr. Rejmil agreed that it would be interesting to have project related documents online, and that success stories have to be synthesised and uploaded to the platform.

Mr. Hamrouni thought that it is not necessary to upload mid-term reports. He said that what matters for him are the experiences of other projects and their final impacts. Detailed information is already available on each project website. Thus, the value added of MENARID could be to emphasise the results of each project.

Mr. Treidel raised the importance of development challenges that farmers in different countries face, which might not have yet been fully addressed or solved. The platform should create a dedicated site for these challenges.

Mr. Abderrahim told the audience that he has all types of documents concerning his project, including documents from the first phase, evaluation reports and studies.

From the above brainstorming activity, it emerged that the types of document that could be shared are:

- Background studies
- Project documents
- Groundwater specific studies and thematic information
- Project updates
- Evaluation reports
- Statistical data
- Library

The accounts and log-in information have been created and given to each participant. Ahmad Al-Mously showed the audience how to upload content online. All Project Managers can now upload documents to the platform.

Knowledge products/stories as brainstorming session

Dr. Aden Aw-Hassan asked the participants to tell the audience which stories (successful and unsuccessful) they would like to share with others. He mentioned the importance of analysing why something had or had not worked and of giving feedback about these experiences (half or one page stories in length). It is important to highlight knowledge or products, including innovation, techniques and experiences of which Project Managers are proud, and that are worth exploring.

Mr. Aladaileh Mamoon, Jordan:

I. Increasing olive oil production through comprehensive activities;
II. Women and CBOs income generating activities;
III. New water-saving techniques for irrigating trees (water box technologies);
IV. Grey water re-use units at household level — for tree production.

Mr. Holger Treidel, UNESCO:

I. Management of Aquifer Recharge.

Mrs. Lamia Emeli, Tunisia:

I. Revenue generating experiences;
II. Information on generating income for women and young graduates;
III. Approaches for production of value added local specialty (food) products to local production of value added production;
IV. Participatory approach for natural resource management.

Mr. Hedi Hamrouni, Tunisia:

I. Evaluation of the cost of natural resources using livelihoods framework-relationship between natural resource degradation and income levels.

Mr. El-hassane Rejmil, Morocco:

I. Pastoral cooperative to manage common resources (rangelands);
II. Community action/development plans for rural development for pastoralists, across their entire area of movement;
III. Combining participatory land development with other approaches;
IV. Approaches to organisation of cooperatives — income opportunities for livestock farmers;

New technique for water harvesting;

I. Vallerani system.

Mr. Djamel Latrech, North Africa - Regional:

I. Farmer to farmer extension approaches capturing and sharing local knowledge from farmers' experiences;
II. Illustrate benefits of solar energy for small farmers for pumping groundwater and drainage;
III. Small scale desalination groundwater to improve soil quality and farmers' income.

Mr. Hichem Lakhdhar, Tunisia:

I. Sustainable GW recharge techniques that bring a possible income to farmers in very dry (low rainfall) areas
II. Community based organisation for rural credit
III. Improving the management of hillside lakes for better soil conservation
IV. Agro-ecosystem planning to produce a book of knowledge (feeds into Community Action plan)

Mr. Hedi Hamrouni, Tunisia:

I. New methodology of evaluation of the impact of the degradation of natural resources on households' capital;
II. Traditional knowledge practices for groundwater management;
III. Water harvesting — best practices from Tunisia.

Mr. Lhoussaine Bouchaou said we need to follow a research approach (context, problem, methodologies and results) that can be applied in the field.

IV.2 MENARID planned activities for 2013

Aden Aw-Hassan

Dr. Aden Aw-Hassan facilitated the last part of the meeting concerning the planning action. He suggested that, depending on time and funds available, two complementary activities could be achieved:

- To send a draft to the project managers to collect their comments about the innovations, then publish this information on the platform,;
- To organize a "write-shop" about some of these techniques. In this case, sharing experiences and innovation would give added value. However, this would require some preparation.

Mr. Hamrouni said a write-shop would require producing a draft version before actually attending the write-shop. The draft would be then polished during the write-shop.

Mr. Lakhdhar agreed with what had been said. He thought that it may help to create discussion groups according to each Project Manager's area of focus.

Dr. Aden Aw-Hassan said that each Project Manager would have to pick one (or more) of the proposed topics and would have to interact with ICARDA. That would allow a knowledge product to be completed by the end of the write-shop.

Mr. Aladaileh Mamoon proposed that experts in product management tools are brought to the write-shop in order to deliver these knowledge products.

Mr. Michael Devlin said we could interact before the write-shop by detailing each technique first, and then come up with a short document that we could discuss during the write-shop.

IV.3 Next steps

The Project Managers will populate the MENARID platform with ready available information that they believe is worth sharing on the MENARID website. This information can be of the following types: innovations, good practices, technologies, life cycle success stories, project briefs, background studies, logical frameworks, results (case studies, synthesis, reports);

- Based on point 2 above (knowledge products/ stories as brainstorming session), Project Managers will work on one or two products (innovations) by project in order to prepare material for the write-shop. In turn, the new Project Coordinator will assist the Project Managers by providing a template and explaining the format of the information needed for the write-shop;
- The write-shop will probably be held in mid-March in Tunisia. It is expected that all 10 projects that form part of the MENARID umbrella participate in this write-shop. Write-shop is a participatory method for producing various types of documents. The purpose of having Project Managers at the write-shop is to generate information derived from field experience and/or relevant expert knowledge, and to document it in a form that is easily accessible to a wider readership. Project Managers will be divided in groups according to the main topic of the write-shop and participate by sourcing and agreeing on information. The groups will present the results of their work in the plenary and will challenge each other with questions to clarify and strengthen the information being provided. The write-shop will finish with an endorsed and finished product;
- During February 2013, the Project Coordinator will visit each of the projects with the aim of assisting projects in preparing material for the 'write-shop' and for 'validating' innovations, technologies, etc. that have been produced in the different MENARID projects;
- A cross-cutting comparative study will be developed by ICARDA, thus systematising and extracting the main driving factors that have led to successful or unsuccessful interventions at farm level. Lessons from innovations and good practices in general will be systematised.

Appendices

Appendix a. Workshop agenda

Day 1: Tuesday 11 December Introductions and MAR lectures	
Session 1 9:00-10:00	Welcome statement – **H.E. Basem Telfah** (Ministry of Water and Irrigation of Jordan) Welcome statement – **Holger Treidel** (UNESCO-IHP) Welcome statements - **Kamel Shideed** and **Aden Aw-Hassan (** ICARDA) Workshop objectives, agenda and presentation of GEF IW LEARN Project – **Lucilla Minelli** (UNESCO-IHP) - Round of self-introductions *Rapporteur: Roberto Telleria (ICARDA)*
10:00 – 10:30	Coffee break
Session 2 10:30-11:30	General introduction on the impacts of both, climate change and human activities on groundwater resources in the MENA region. Lecturer: **Holger Treidel** (UNESCO-IHP) MAR techniques and examples successfully applied in light of climate change adaptation: Case study in Morocco Lecturer: **Lhoussaine Bouchaou** (Ibn Zohr University of Agadir)
Session 3 11:30 – 13:00	MAR as linking pin between land and water management: Types of MAR, history of development, practical examples worldwide, link between land and water management and reuse of water, consequences for water governance issues Lecturer: **Ebel Smidt** (IGRAC- Delft University of Technology-SG Services) Q&A with participants
13:00 – 14:30	Lunch Break
Session 4 14:30 – 16:00	Managed Aquifer Recharge "MAR" in Jordan Lecturer: **Anke Steinel** (BGR) represented through **Tobias El-Fahem** (BGR) MAR in the MENARID countries: actual situation and potential. View from the Jordanian Valley Authority Lecturer: **Elias Salameh** (University of Jordan) Q&A with participants
16:00 – 16:30	Coffee Break
Session 5 16:30 – 18:00	Practical design workshop: Material will be provided for a number of case situations and the participants can discuss a design for each case in groups of 3-4 persons. For each case a group will present its design and the others comment. Lecturers: **Ebel Smidt** (IGRAC) and **Elias Salameh** (University of Jordan)

Day 2: Wednesday 12 December **FIELD TRIP to MAR site: Wala dam in Madaba Governarate**	

Day 3: Thursday 13 December **Presentations of MENARID PMs, Partners and MENARID Platform**	
Session 6 9:00-10:30	Presentations from MENARID PMs Each presentation will be followed by discussions and comments from MAR experts - **Houshang Jazi,** Iran (tbc) - **Mamoon AL Adaileh** and **Khaled HABASHNEH,** Jordan - **El hassane REJMIL,** Morocco - **Hichem Lakhdhar,** Tunisia - **Awatef LARBI MESSAI,** Tunisia - **Abderrahim BOUTALEB,** Morocco *Facilitator: Lhoussaine Bouchaou* *Rapporteurs: Holger Treidel/Lucilla Minelli*
10:30-11:00	Coffee Break
Session 7 11:00-12:30	Presentations from MENARID PMs (cont.) and Partners Each presentation will be followed by discussions and comments from MAR experts - **Djamel Latrech,** OSS/Regional - **Bilquis Anwer A. Sattar ,** Yemen - **Hedi Hamrouni / Lamia Jemeli,** Tunisia - **Mohammad Momani:** Nuclear Techniques Application for Determination Artificial Recharge efficiency in Jordan **- Aden Aw-Hassan and Roberto Telleria** - The Limits of Groundwater Mining in Dry Areas *Facilitator: Lhoussaine Bouchaou* *Rapporteurs: Holger Treidel/Lucilla Minelli*
12:30 – 14:00	Lunch Break
Session 8 14:00 – 15:00	Wrap-up / conclusions of thematic discussions
15:00 – 15:30	Coffee Break
Session 9 15:30 – 17:30	Presentation of MENARID platform by ICARDA Presenters**: Michael Devlin** (ICARDA) and **Colin Webster** (ICARDA) *Rapporteur: (tbd)*

Day 4: Friday 14 December MENARID Planning meeting for 2103	
Session 10 9:00-10:30	**MENARID Planning meeting – topics to be included** • Review and adoption of minutes • Review of MENARID workshop in Rabat • Partners Brainstorming Session • Impact Assessment Strategy • Introducing new project manager
10:30-11:00	Coffee Break
Session 11 11:00-13:00	Activities planned by country/project Mr Houshang Jazi (tbc) (Iran) Mr. El hassane REJMIL (Morocco) Mr Abderrahim BOUTALEB (Morocco) Mr Hichem Lakhdhar (Tunisia) Mr Djamel Latrech (Tunisia) Ms Awatef LARBI MESSAI (Tunisia) Mr Hedi Hamrouni (Tunisia) Ms Lamia Jemeli (Tunisia) Mr Bilquis Anwer A. Sattar (Yemen) Mr Mamoon AL Adaileh (Jordan) Mr Khaled HABASHNEH (Jordan) Collaborating Institutions: Lucilla Minelli Holger Treidel Aden Aw-Hassan Michael Devlin Colin Webster Roberto Telleria Thematic Break-out Group Discussions. *Rapporteur: Hugo Remaury (ICARDA)*
13:00 – 14:30	Lunch Break
Session 11 (cont.) 14:30 – 17:00	Activities planned by country/project (cont). Closing remarks

Appendix b. Fictitious cases for role play

CASE 1. MAR AND INTEGRATED WATER RESOURCES MANAGEMENT IN A COASTAL AREA

BACKGROUND INFO: A governorate (A) of about 300 km coastline by 100 km inland with a semi-arid climate has a population of three million people. One and half million people are living in a large town, one million in three middle size towns , four hundred thousand in ten small towns (10.000-75.000 inhabitants) and the remaining population of hundred thousand people live in fifty villages and rural communities. A schematized map and a hydrogeological profile are provided below. Some additional data are:

- Average annual rainfall: 300 mm with peaks till 600 mm and low years with less than 50 mm
- Climate change is expected to reduce rainfall 10-20% and increase the amount of intensive storms
- Three ephemeral rivers bring in an average of 400 million m3/year, 90% of this water now runs off to the sea causing damage during the floods despite existing defense works along its banks. Upstream stakeholders along these rivers in a neighboring also semi-arid governorate (B) with average 400 mm rain per year plan to use this water as well. A third governorate (C) which is the source area of the rivers has not shown interest as it has less population and an average rainfall of 600 mm/year. First talks between A and B about a joint plan are scheduled within a month.
- Plans exist for a desalination plant to be built near the main city in the governorate, with a capacity between of 200.000 and 500.000 m3/day.

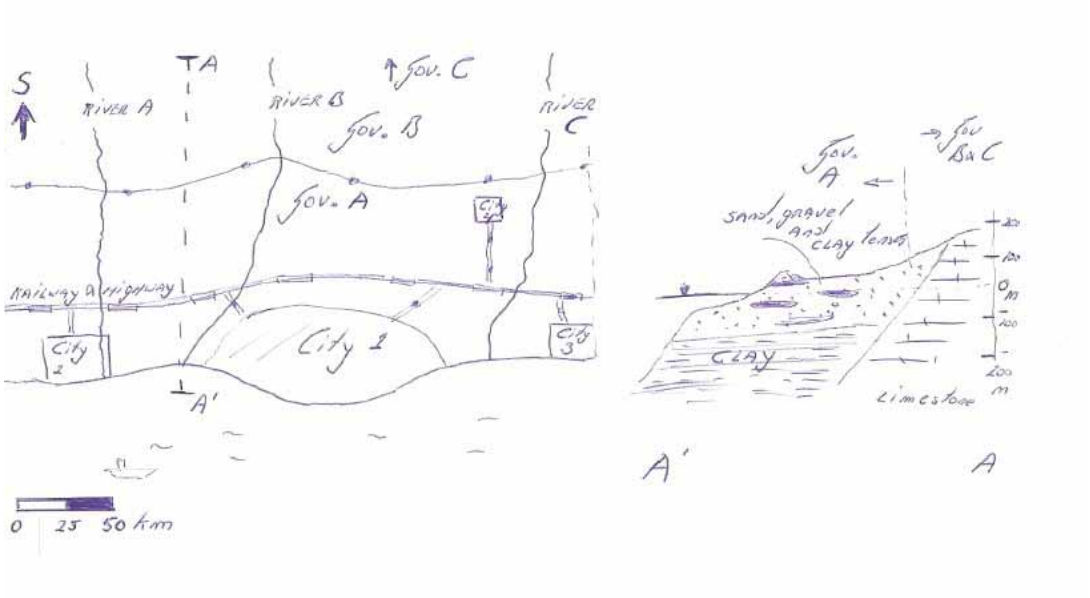


Figure 1. Schematic map and cross-section

CASE 2. MAR AND INTEGRATED WATER RESOURCES MANAGEMENT IN A TRANSBOUNDARY RIVER

BACKGROUND INFO: A river system called MENAMAR of about 2000 km length includes four countries:

- Up: a mountainous area average 900 m above sea level. Annual rainfall is 1200 mm per year. It contributes 60% of the annual natural discharge of the MENAMAR river. Expectations for climate change effects are between a decrease and increase of average rainfall of about 10%. Higher extremes are expected as well.

- Middle: a mostly flat area at average altitude of 200 m asl with some hills till 500 m. Annual rainfall is 500 mm per year. It contributes 25% of the annual natural discharge of the MENAMAR river. Expectations for climate change effects are indicating a 10 % decrease in rainfall and higher extremes.

- Down: a flat area at average altitude of less than 100 m asl with some hills till 250 m. Annual rainfall is 250 mm (at the coastal strip of max. 50 km wide) till 50 mm per year more inland. . It contributes only 5% of the annual natural discharge of the MENAMAR river. Expectations for climate change effects are indicating a 10% decrease in rainfall inland, 10% increase in the coastal areas and higher extremes everywhere.

- Side: a mostly flat area at average altitude of 200 m asl with some hills till 500 m. It contributes only 10% of the natural annual discharge of the MENAMAR river. Annual rainfall is 500 mm per year. Expectations for climate change effects are indicating a 10 % decrease in rainfall and higher extremes.

At the border of countries Down and Middle a dam is planned to be constructed with a capacity of 200 billion m3. Both countries will profit from the water storage.

The average natural discharge of the MENAMAR river is 300 billion m3. The actual use for the different sectors in the countries is:

Country	Total (BCM/y)	Water supply (%)	Agriculture (%)	Industry (%)
Up	70	5	85	10
Middle	100	20	30	50
Down	80	15	75	10
Side	20	5	65	30
Discharge to the sea	30			

The countries Middle, Side and Down are sharing a fossil groundwater reservoir with a capacity of 30.000 BCM. Middle is actually using only 1 BCM per year, Side 20 BCM and Down 5 BCM.

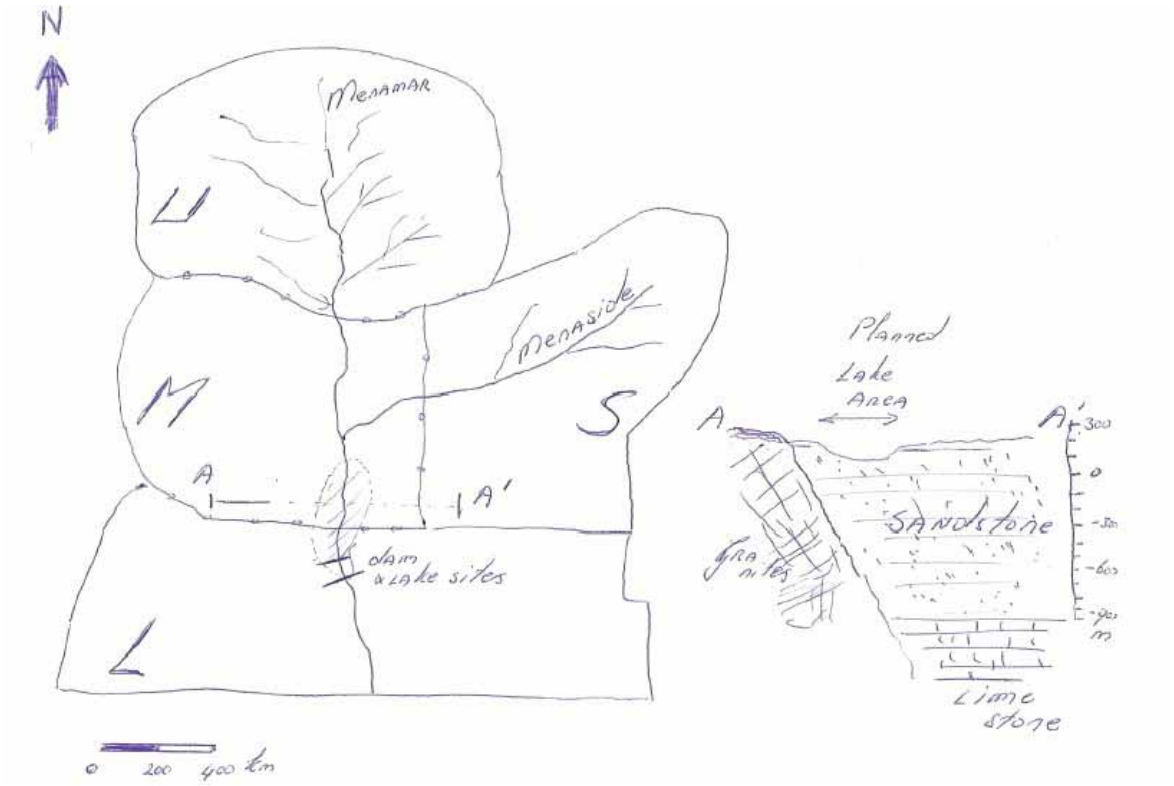


Figure 1. Schematic map and cross-section

Group work

An international committee is formed to advice on the dam construction and better integration of land and water resources management for the coming 25 years. You are the permanent members of the committee: a retired international diplomat, an integrated land and water use planner, a dam specialist and a groundwater specialist. Prepare a master plan including large and small scale MAR projects which is politically acceptable in the four countries an present this plan in maximum four PowerPoint sheets highlighting the key points of your plan.

Appendix c. Useful Resources on MAR

- IAH-MAR Managed Aquifer Recharge Forum: http://recharge.iah.org/recharge/
- Publication "Strategies for Managed Aquifer Recharge (MAR) in semi-arid areas" http://unesdoc.unesco.org/images/0014/001438/143819e.pdf
- IGRAC Global Inventory of Artificial Recharge http://www.un-igrac.org/publications/155
- 8th INTERNATIONAL SYMPOSIUM ON MANAGED AQUIFER RECHARGE (ISMAR8) http://ismar8.org/
- Akvopedia on Managed Aquifer Recharge (MAR) http://akvopedia.org/wiki/Managed_Aquifer_Recharge_%28MAR%29

Appendix d. List of participants

Mr. Haddioui Abdellatif	Mr. Hichem Lakhdar
Mr. Mamoon Al Adaileh	Mr. Djamel Latrech
Mr. Ahmad Al-Mously	Ms. Awatef Larbi Messai
Mr. Rabhi Am	Mr. Ouchtarmoune Mha
Mr. Bilquis Anwer A. Sattar	Ms. Lucilla Minelli
Mr. Ahmed Aouali	Mr. Mohammad Momani
Mr. Aden Aw-Hassan	Mr. El Hassane Rejmil
Mr. Lhoussaine Bouchaou	Mr. Hugo Remaury
Mr. Abderrahim Boutaleb	Mr. Elias Salameh
Mr. Michael Devlin	Mr. Ali Sawarieh
Mr. Tobias El-Fahem	Mr. Kamei Shideed
Mr. Khaled Habashneh	Mr. Ebel Smidt
Mr. Nasri Hadad	Mr. Ali Subah
Mr. Hedi Hamrouni	Mr. Basem Telfah
Mr. Houshang Jazi	Mr. Roberto Telleria
Ms. Lamia Jemeli	

Appendix e. Group Picture

For more information on the MENARID Portfolio and
the groundwater components of the GEF IW:LEARN Project

please contact:
Ms. Lucilla Minelli, l.minelli@unesco.org

groundwatercop.iwlearn.net/menarid