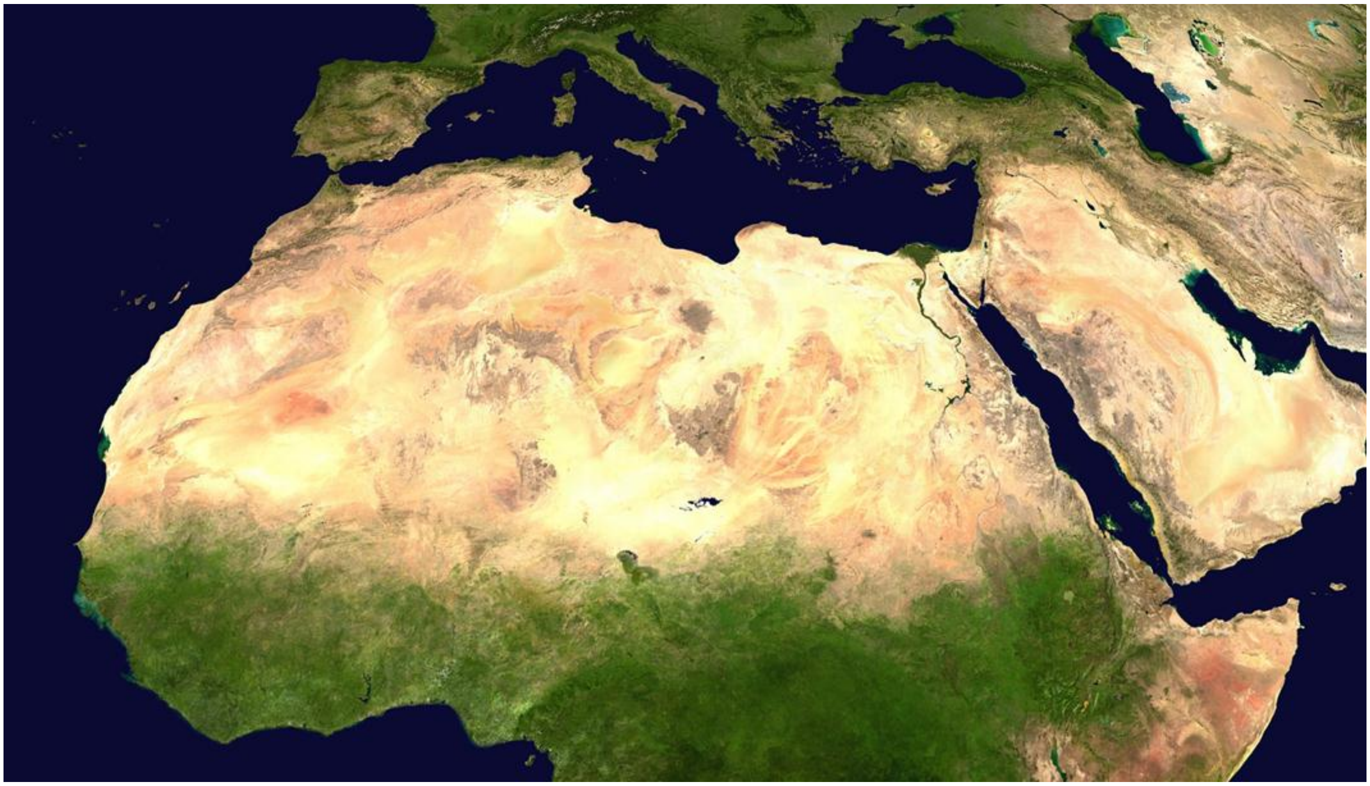
Regional Technical Cooperation Programme

Adaptation to Climate Change in the Water Sector in the MENA Region (ACCWaM)



Mainstreaming Climate Change Adaptation

in

National Policies, Strategies and Action Plans

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

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Executive Summary

The need for climate change adaptation

The MENA region already has one of the lowest water availabilities per capita world-wide, and at the same time its water sectors is projected to become most severely affected by climate change from lower precipitation – further reducing water availability – from higher temperatures – increasing agricultural water demand – and from increasing variability – compromising reliability of water systems.

So far, other pressures on water resources, in particular population and economic development have been stronger than those from climate change. Accordingly, there is a widespread perception of climate change to materialize only in the distant future in combination with climate scenarios perceived as still being very uncertain, which is unfounded in view of already high climate risks today and the large agreement among climate models about the decrease of precipitation in the MENA region (on top of general warming). This misconception has contributed to an ignorance of national water planning in terms of climate change and a lack of mainstreaming climate adaptation into water management. Even in cases where climate adaptation has been addressed in water strategies or plans, implementation of measures and enforcement of regulations is often lacking. So awareness-raising about climate change and its impact (e.g. with the help of new regional climate scenarios being made available by UN-ESCWA) and about win-win opportunities through technical, economic and institutional adaptation, many of which at the same time are IWRM objectives, is important.

The three pilot countries, Lebanon, Jordan and Egypt can benefit from and at the same time contribute to the implementation of the Arab Strategy for Water Security through sharing of (water-related) adaptation and (energy-related) mitigation experience, and through a joint approach on tapping financial support e.g. from new climate adaptation funds.

An integrated approach to adaptation

It has been frequently acknowledged, that climate adaptation and mitigation need to be integrated, and the MENA region provides ample opportunities towards that end. While the water sector plays a key role in climate adaptation, mitigation focuses on the energy sector. Recent studies on the so-called "water-energy nexus" confirm the potential synergies to be derived from mainstreaming climate adaptation in the water sector, while simultaneously addressing opportunities for co-management with energy (and also land use). Such an integrated ("nexus") approach is likely to build resilience and reduces vulnerability to the combination of pressures acting upon the MENA countries' water systems, including climate-related shocks.

Climate adaptation mainstreaming and any nexus approach need to be implemented through concrete "entry points", i.e. on-going or planned activities, strategies or policies. There are several windows of opportunity given that a number of water and climate plans and strategies are to be revised in the near future. The three pilot countries have developed climate adaptation (and mitigation) strategies in the form of National Communications to the UNFCCC. These communications remain rather vague on concrete measures, while water strategies and plans on the other hand are more concrete, but not sufficiently coordinated with other sectors' strategies. Any strategies and policies, including those on water and climate lack of implementation and enforcement. Some of them have not even been translated into action or investment plans, due to a lack of funding, capacity or political will.

The current attention to the nexus concept provides opportunities for much needed implementation of climate adaptation, integrated with climate mitigation. If existing sectoral plans, such as national water master plans are coordinated with other sectors such as energy, land, agriculture and environment, synergies and co-benefits can be derived and negative externalities and mal-adaptation avoided. Integrated solutions exist e.g. in the form of low energy water distribution systems, energy recovery from wastewater treatment, and multi-use systems. Institutional support for integrated adaptation could come e.g. from inter-ministerial committees and water user associations.

Lebanon has more flexibility in climate adaptation compared to most other MENA countries, due to its relatively high water availability, low population growth rate, and diversified economy. It should strive to pro-actively secure this advantage and maintain its resilience to climate and other pressures. Besides the large untapped potential for water demand management and wastewater reuse, water storage plays a special role given the quick runoff of water to the sea and the projected loss of snow water storage. Avoiding sea water intrusion in coastal aquifers and water-smart land planning are other urgent adaptation measures in Lebanon. When exploiting the country's hydropower potential, full integration with water planning ("the water-energy nexus") will be important. The fact that Lebanon has a Ministry of Energy and Water provides an excellent opportunity for this integration.

Jordan is one of the most water scarce countries, so that only a small fraction of its food requirements can be met from local production. Given its very high population growth rate and the impacts of climate change, enormous additional pressures on Jordan's water system are projected. While Jordan is exploiting any possible water supply and demand side measures, there is a bias towards large scale, centralized and energy-intensive supply-side solutions (and similarly water-intensive solutions in the energy sector), such as long distance transfer of fossil groundwater and a planned conduit from the Red to the Dead Sea. Small scale, decentralized and demand side measures, including decentralized wastewater treatment, loss reduction, rainwater harvesting, aquifer storage and the use of renewable energy in water supply receive relatively less attention. Virtual water imports will have to be integral part of any future climate adaptation and water strategy. Turning Jordan's predicament into an advantage, the country could become a role model in climate adaptation, not only in terms of its advanced technologies, but also its adaptation planning (through country-wide standardized WEAP planning), the development of an integrated water and climate database and the integration of climate issues in the national water strategy.

Egypt's water originates outside of the MENA region, which makes the country less vulnerable to climate impacts from reduced precipitation than most other countries in the region. Instead climate vulnerabilities are related primarily to increasing water demand with higher temperatures and seawater intrusion into coastal aquifers (and potentially loss of agricultural land) due to sea level rise. Even more than in the other pilot countries, climate adaptation in Egypt requires economic diversification beyond agriculture, given that agriculture still uses 80% of all water and employs about 30% of the total workforce. At the same time, there is still significant potential for improving agricultural water productivity in agriculture and hence reducing water demand. Also, Egypt's downstream position and in particular the situation in the Nile delta requires water quality improvements as a means to secure water availability. Given Egypt's special situation as downstream riparian in the Nile basin, adaptation hinges on trans-boundary collaboration. Given Egypt's rapidly growing demand and the projected water resources development upstream, there is an urgent need for increasing the overall basin water productivity and benefits derived through collaboration, e.g. when locating additional agricultural areas, hydropower production and water storage. Fossil groundwater may provide some relief from water scarcity in the short term, until the transition to a less water-intensive economy is achieved, but it shouldn't be viewed as a sustainable adaptation option.

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List of Abbreviations

ACA	Arab Climate Alliance
ACCWaM	Adaptation to Climate Change in the Water Sector of the MENA Region
ACSAD	Arab Center for the Study of Arid Zones and Dry Lands
AUB	American University of Beirut
BGR	Federal Institute for Geosciences and Natural Resources, Germany
Bm^3	Billion cubic metres, cubic kilometre
CBA	Community-Based Adaptation
CCRA	Climate Change Risk Assessment
CORDEX	Coordinated Regional Downscaling Experiment
COP	Conference of the Parties
EEAA	Egyptian Environmental Affairs Agency
ESCWA	UN Regional Economic and Social Development Commission in Western Asia
FAO	United Nations Food and Agriculture Organisation
FoEME	Friends of the Earth Middle East
GEF	Global Environment Facility
GIZ	Gesellschaft für Internationale Zusammenarbeit, Germany
GDP	Gross Domestic Product
ICI	International Climate Initiative,
ICZM	Integrated Coastal Zone Management
IFAD	International Fund for Agricultural Development
IWRM	Integrated Water Resources Management
KFW	KFW Banking Group, Germany
LAS	League of Arab States
LDCF	Least Developed Country Fund
LEAP	Long-range Energy Alternatives Planning System
MALR	Ministry of Agriculture and Land Reclamation, Egypt
MCM	Million cubic meters
MDG	Millennium Development Goals
MENA	Middle East and North Africa
MoE SNC	Ministry of Environment Second National Communication
MoEW	Ministry of Energy and Water, Lebanon
MWI	Ministry of Water and Irrigation, Jordan
MWRI	Ministry of Water Resources and Irrigation, Egypt
NGO	Non-governmental organisation
NWMP	National Water Master Plan
NWRC	National Water Research Centre, Egypt
RCM	Regional climate model
SCCF	Special Climate Change Fund
SNC	Second National Communication to the UNFCCC
SMART	Sustainable Management of Available Water Resources with Innovative Technologies
SMHI	Swedish Meteorological and Hydrological Institute
TNC	Third National Communication to the UNFCCC
TWh	TWh (Terawatt-hours) of electricity
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change
WEAP	Water Evaluation and Planning System

1 Climate Adaptation in the MENA Region

Adaptation in the regional context

Our stakeholder generally agreed that the region's water systems are subject to **various interacting pressures** in addition to climate change, in particular rapid population growth, urbanization, and economic development (resulting also in greenhouse gas emissions growing faster than global average) and environmental degradation. The resulting increased demand in particular for irrigation and municipal use exerts additional pressures on water resources. Consequently water demands have outstripped supply and almost all MENA countries have become too water scarce to produce all required food locally (only Sudan and Syria have under the given crop mix and crop water productivity enough water to be food self-sufficient, Gerten et al 2011) and hence are vulnerable to price shocks on world markets. The Nile and Jordan are international rivers which illustrate this by having become "closed basins", with no remaining unallocated water. Hence adaptation to climate change, which is projected to become a major additional pressure in the MENA region, needs to be embedded in the context of adaptation to other pressures which are generally considered to be more important in the short to medium term (e.g. Farajalla et al 2011). Additionally, many of the MENA countries may share borders or resources with non-Arabic countries, or countries in the midst of conflict. This adds an additional challenge in terms of adaptation and managing shared water resources in a contentious environment.

Additional **climate change** pressures (real or perceived) can serve **as an opportunity** to promote much needed technological, socio-economic and institutional innovation and adaptation in the water sector. The attention to climate change can raise awareness for measures, reforms and behavioural changes that have long been overdue and that are win-win options for countries, with or without climate change. National climate adaptation strategies, for example, can promote horizontal and vertical integration - across disciplines, sectors, ministries and hierarchical levels and scales, which are urgently required in the water and other sectors (OECD 2011).

However, **climate change** is perceived by many stakeholders in the MENA region **as a distant threat**, and currently much less important than other pressures. It is worthwhile to point out that several water-related decisions made today have a lifetime that reaches well into the second half of this century (e.g. dams, transfers, urban and spatial planning, or new energy systems). At the same time, there is plenty of evidence to suggest that climate variability is going to pose growing threats to water systems in the MENA region in the near term, suggesting more intense, longer and more frequent droughts and increasing uncertainty in rainfall and water availability. In fact, various stakeholders expressed their personal impression that they have already been faced with increasing variability for some time.

Current responses to climate and other pressures and acute crises (e.g. droughts) are often limited to **emergency and coping measures** that are only short-term and reactive. These responses may in fact compromise future opportunities for adaptation, leading to what is commonly referred to as *maladaptation*. Mainstreaming climate change however is about pro-active, longer term and integrated planning and – if necessary - transformative development that address root causes of **vulnerability**, and strengthens human security and sustainability. Rural poor communities, unskilled labour, as well as internally displaced people, are generally most exposed and most vulnerable to climate risks, e.g. due to their dependence on natural resources and lack of resources to respond to change (World Bank

2011). These vulnerabilities are aggravated in most MENA countries by low investments in social safety nets and limited public services such as water supply. Hence adaptation needs to be mainstreamed in conjunction with poverty alleviation, development and environmental planning efforts.

Adaptation objectives

The goal of adaptation to climate change and other pressures is to **build resilience** (this is also an expected impact of the ACCWaM project), i.e. to strengthen livelihood and other systems so they maintain their functions under stress (e.g. droughts) and change, through adaptation or – if necessary - transformation (Folke et al 2002, Walker at al. 2004). A resilience approach tries to balance between short term optimization and long term sustainability. Characteristics of a resilient system include e.g.: a high level of diversity and of connectivity (e.g. between institutions at different scales and the propagation of information and learning up and down across these scales) and the level of redundancy within a system (Mitchell et al 2012). An important aspect of resilience is that of critical thresholds, beyond which current practices no longer work. Such critical thresholds may be reached through rapid or gradual change e.g. loss of groundwater recharge or loss of rainfed agriculture when rainfall decreases below a certain threshold; and once surpassed, systems fail. A recent example of this is the drought in the northeast of Syria a few years back, which pushed local systems beyond their threshold: first surface water resources dried up, a situation to which farmers have been used to and are able to adapt to, e.g. by tapping shallow aquifers. However when the drought continued and groundwater levels dropped, traditional coping mechanisms failed, and eventually hundreds of thousands of farmers had to abandon their villages and migrate to cities and neighbouring countries. The over-allocation and declining flow of the Jordan River is another important example of a critical biophysical threshold, the on-going degradation of the river's aquatic ecosystems and the Dead Sea and its adjacent areas is an important indicator of the resulting ecological regime shift.

A resilient water system can withstand combined climate and other pressures and the uncertainties associated with them. Robust adaptation measures can also deal with uncertainty and hold under a range of future conditions. A resilience approach and the identification of critical thresholds can help to find entry points for adaptation, e.g. diversification (a key strategy to increase resilience) of water supplies, cropping and farming systems, income opportunities (less dependent on water and other natural resources), but also water demand management – compare also with the Arab Climate Resilience Initiative[1]

Adaptive management refers to a management regime that is sufficiently flexible to account for new knowledge, e.g. improved climate and climate impact scenarios, when becoming available. A transition to adaptive management can also build resilience or robustness to uncertainty of water systems – see figure 1:

[1] http://arabclimateinitiative.org/

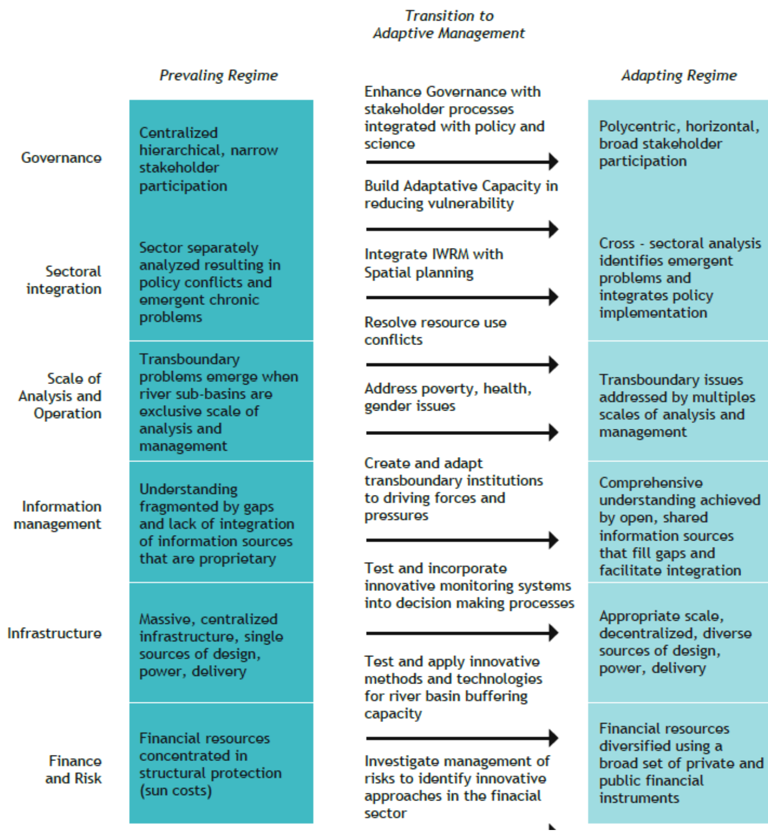

Figure 1
Transition from sectoral, centralized to integrated, diversified and adaptive water management and governance, Plan Bleu (2011) after Pahl Wostl (2005)

Ecosystem-based adaptation (EBA) has been proposed for strengthening resilience and maintaining flexibility under future conditions, for which conventional hard infrastructure approaches may not be sufficient (Jones et al 2012). Such ecosystem-based approaches harness the natural capacity of ecosystems to buffer against climate change impacts; for example, aquatic ecosystems and wetlands purify water and buffer flood pulses. Agroforestry systems stabilize land, sequester additional carbon and mitigate heat extremes. The Jordan Desert Ecosystems and Livelihoods Project in the Badia region provides an example which aims at sustaining natural resources and ecosystem services and livelihoods through rangeland rehabilitation, water harvesting and storage, ecotourism and other income diversification (World Bank 2011). This project which can also reduce vulnerability to climate change is jointly implemented by the ministries of environment and water.

A complementary approach to ecosystem-based adaptation is community-based adaptation (CBA), which emphasizes the need to break down national adaptation strategies all the way to the community level context and align them with on-going sustainable and economic development and also poverty reduction objectives and strategies for reducing climate risks (Schipper 2007; Ayers and Huq 2008; Heltberg et al. 2010).

Available guidance documents emphasizing mainstreaming

Mainstreaming suggests a more effective use of available resources, rather than designing, implementing and managing climate change adaptation separately from on-going management (Klein et al. 2007). In thinking about the best approach for mainstreaming climate change adaptation into the water sector in the MENA region, we have looked at several available guidance documents that have emerged from practical experiences. For example, the *Mainstreaming Disaster Risk Reduction: A tool for development organizations* (Tearfund, 2005), *Mainstreaming Climate Change Adaptation: A Practitioner's Handbook* (CARE International in Vietnam, 2009) and the *Screening Tools and Guidelines to Support the Mainstreaming of Climate Change Adaptation into Development Assistance – A Stocktaking Report*, prepared for UNDP by Olhoff and Schaer (2009) provide valuable guidance also for the MENA context. They cover all the steps from assessing vulnerability through identifying adaptive capacity, designing and implementing adaptation measures to monitoring the success and effectiveness of implementation. They reflect a more comprehensive approach to adaptation planning, including the complexity of vulnerability and its reduction (see also on-going vulnerability assessment of the MENA water sector by Adelphi), and provide a better understanding of what is necessary for adaptation planning. These documents embrace the concept of mainstreaming adaptation, which essentially means integrating awareness of climate change into all stages in policy- and decision-making, especially in key sectors that are most sensitive to climate change.

Financing adaptation

In all three pilot countries (Lebanon, Jordan and Egypt) a lack of **funding** was identified as a key constraint to implement proposed climate change adaptation measures and strategies. Egypt's National Communications even lists "assuring sustainable adaptation funds" as a priority. Below we offer an overview of adaptation in the MENA region within the context of potential funding sources at the global level. We suggest that a regional adaptation initiative could prepare MENA countries so they are ready to apply for adaptation funding; by the time funding opportunities becomes available. Global negotiations on climate change have produced new mechanisms for adaptation funding. This includes various channels through which countries can access finance. The majority of climate funding in the MENA region has been for mitigation projects, mostly large scale renewable projects such as solar thermal energy. Mitigation funding has gone mostly to a small number of countries, including Morocco and Egypt.

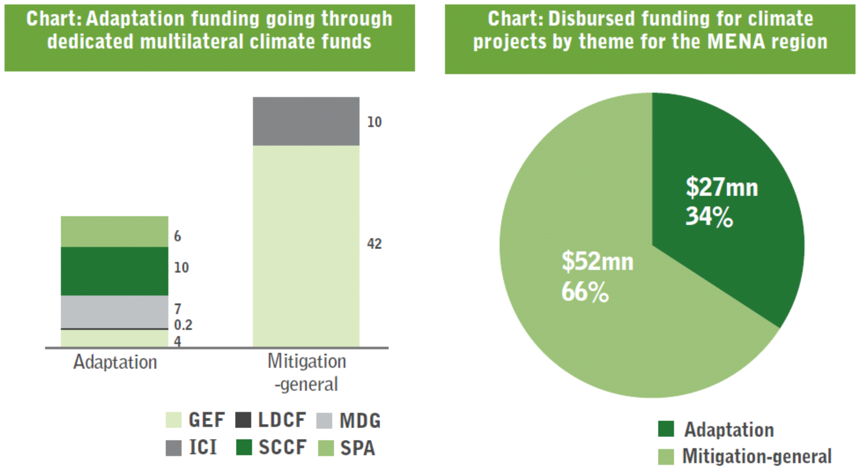

Figure 2

Summary of climate finance spending in the MENA region as of November 2011, from Nakhooda et al (2011). GEF is the Global Environment Facility, LDCF is the Least Developed Country Fund, MDG is the Millennium Development Goals Achieving Fund (presumably via the Environment and Climate Change thematic window), ICI is the German International Climate Initiative, SCCF is the Special Climate Change und SP is the Strategic Priority on Adaptation – a GEF fund that is now closed.

The **Special Climate Change Fund** has approved projects in **Egypt** on adaptation in the Nile Delta through Integrated Coastal Zone Management (ICZM), **Morocco** on integrating climate change in development and disaster prevention to increase the resilience of agriculture and water sectors and **Jordan** on a pilot irrigation project to face climate change impacts.[2] There was also a project in Yemen funded by the now-closed **Strategic Priority on Adaptation**, administered by the GEF, on adaptation using agro-biodiversity resources in the rain fed highlands. None of the countries in the Pilot Program for Climate Resilience are from the MENA region.

Afghanistan and Yemen (and depending on the definition, Sudan, Somalia and Djibouti) are the only countries in the region eligible for **LDCF** funding, as they are the only countries defined as 'least developed countries' under the UNFCCC. The LDCF supports the development and implementation of National Adaptation Programs of Action. Both Afghanistan and Yemen have produced National Adaptation Plans of Action (NAPAs) (both in 2009) and each have received support from the LDCF. Of the 12 high priority projects listed in Yemen's NAPA[3], two explicitly addresses water impacts (use of grey and treated waste water – $3.2m, and rainwater harvesting - $2.81m[4]), whilst several of the other projects would build capacity relevant to mainstreaming water adaptation. Sudan also produced a NAPA in 2007 and Djibouti in 2006.

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[2] See http://www.climatefundsupdate.org/listing/special-climate-change-fund

[3] See http://www.adaptationlearning.net/sites/default/files/yem01.pdf

[4] See http://unfccc.int/files/cooperation_support/least_developed_countries_portal/napa_project_database/application/pdf/napa_index_by_country.pdf

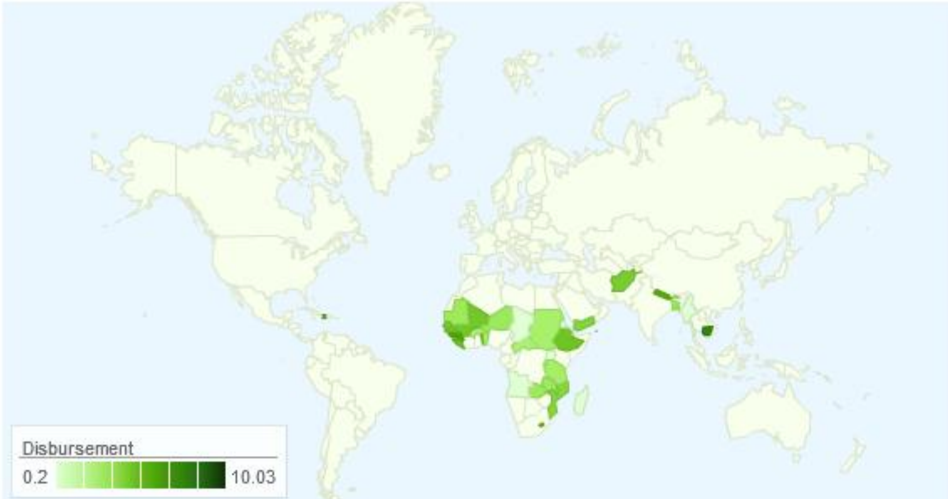

Figure 3
Distribution of LDCF funding by country, source: Climate Funds Update. Note – Yemen and Afghanistan are the only MENA recipient countries. The vast majority of the funding has gone to sub-Saharan Africa and the Asia and Pacific region.

The **Adaptation Fund**, according to Climate Funds Update[5] (as of March 2012), has approved two projects in the MENA region, neither of which dealt directly with water, but both of which could have had some nexus components or represent the mainstreaming of adaptation relevant to water: one in Egypt on climate resilient food security and one in Lebanon on climate smart agriculture.

Climate Smart Agriculture: Enhancing Adaptive Capacity of the Rural Communities in Lebanon (AgriCAL) has IFAD as implementing agency and is in the process of requesting financing from Adaptation Fund. The goal is "to increase community resilience and adaptive capacity to climate change in Lebanon" by implementing "adaptation measures in the agriculture sector in three highly vulnerable" areas. This project is considered the first in Lebanon to focus only on adaptation to climate change in the agriculture sector[6].

The **Green Climate Fund** was established at COP16 of the UNFCCC in Cancun to assist developing countries in achieving the objectives of the UNFCCC, but is not yet operational. Discussions about its structure and the membership of its board dominated subsequent conferences in Durban in 2011 (COP17) and Bonn in 2012. The GCF Board met for the first time in August 2012. Once operational, the GCF will offer an additional – perhaps the main – source of adaptation finance for MENA countries.

These global funds are supplemented by bilateral climate change funding directly from donor countries, as well as potential investments in adaptation from regional/ Arab investment funds. Given the explicit goal of the Arab Strategy for Water Security (LAS 2012)

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[5] See http://www.climatefundsupdate.org/listing/adaptation-fund

[6] http://adaptation-fund.org/sites/default/files/AFB.PPRC_.9.16.Rev_.1%20Proposal%20for%20Lebanon_0.pdf

to reduce inequality among Arab countries, we suggest that the ACCWaM project could make recommendations to regional Arab investments funds, e.g. the OPEC Fund for International Development (OFID), how to invest in the region into integrated (win-win) climate adaptation and mitigation strategies to support economic development in the poorer countries. With that, these funds could support sustainable development in the region.

Measures that mainstream climate change adaptation into water management would be eligible for funding from several of the funds mentioned above.

Adaptation finance is of course not limited to the water sector. Eligible projects will include those that address climate impacts in other sectors, ideally in ways that increase the resilience (or reduce the risks) to water resources, for example by improving irrigation efficiency or agricultural practices. Similarly, much of the funding through these funds as well as other finance mechanisms such as the **Clean Development Mechanism**, could be used to invest in greenhouse gas mitigation techniques or measures that could also positively affect the management of water resources in a future climate (e.g. in solar power systems that could be used for desalination). So we emphasize once more the opportunities for a nexus approach to adaptation and mitigation.

In general, very few small scale projects – and few adaptation projects of any size – have received international funding in the MENA region. This may be partly due to a lack of awareness and capacity for making the necessary applications, which can be burdensome on applicants and require good knowledge of (and in some cases relationships with) the relevant implementing agencies and funding institutions. It is also unclear how recent political instability has affected implementation of approved projects, and also which effects the Arab Spring in general has had – and will have in future – on climate relevant and other environmental decisions, including the mainstreaming of adaptation in water strategies.

Altogether, despite their high vulnerability and pressing needs, as described in this document, MENA countries have so far been slow to take up opportunities to access climate finance. This may be linked somewhat to the position of many regional countries and in particular the OPEC group in the global climate change negotiations, where some MENA countries have resisted climate mitigation (or demanded high levels of compensation in the event of a global deal) out of a fear of the negative impact this may have on their fossil fuel income[7]. Here is another entry point for a regional project, in identifying opportunities, synergies and economic gains from holistic climate adaptation and mitigation approaches.

Because access to climate funding is determined by a country's relative vulnerability and the strength of its application (not its position on global mitigation targets) **opportunities for finance** should be pursued with more vigor. Bilateral and multilateral lenders and development partners can play an important role in assisting MENA countries to apply for climate finance to be used in mainstreaming adaptation. This is especially the case, for example with the countries that are eligible for funding under the LDCF, where recipients can only apply for finance for the 'additional costs' of climate change[8]. In practice this

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[7] The pattern varies between MENA countries, with some high emitting and gas- and oil-rich countries in strong opposition, whilst others (e.g. Morocco and UAE) position themselves as potential leaders in clean technology.

[8] for further information see www.thegef.org/gef/sites/thegef.org/files/documents/Clarification%20on%20Additional%20Cost%208%20May.pdf

requires applicants to seek match funding (e.g. from bilateral or alternative multilateral sources) to supplement the ‘additional’ finance offered by the funds. For mainstreaming adaptation in particular, it is often difficult to single out the ‘additional’ element of funding that is required for climate change (as opposed to business-as-usual), but this does not present an insurmountable barrier to accessing the available finance, particularly where bilateral donors can provide support.

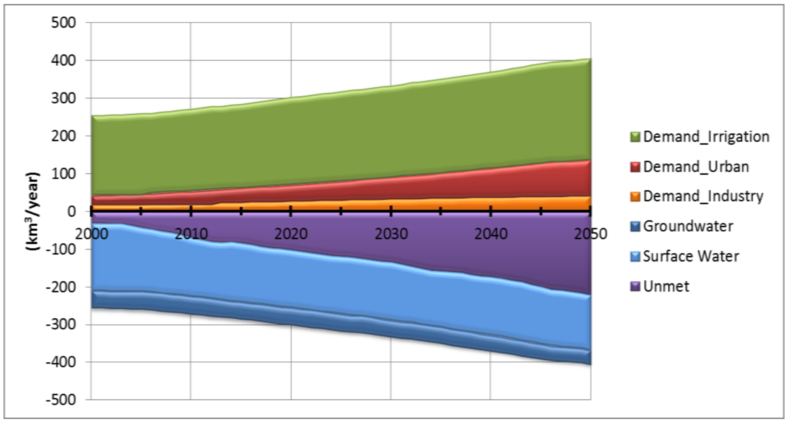
So besides using current development funding for mainstreaming climate change adaptation into water (and related) sector projects – and using non-water related funding in ways that support improved water management (e.g. agricultural development and land management), GIZ and other donors should prepare the MENA region for these new opportunities, including new programs by the donors themselves on climate change adaptation. These new programs need to be aligned from the beginning with existing development activities, in order to emphasize that climate change is one more pressure among several others, all of which need to be addressed in concert. That may involve awareness raising and information sharing about existing and planned climate adaptation and mitigation funds and to some extent also “repackaging” of various water management investments and interventions as climate adaptation and/or mitigation measures. For that it is worth emphasizing once more that many of the proposed climate change adaptation measures are also sound IWRM measures even without climate change.

Scientific underpinning for mainstreaming climate adaptation

While stakeholders emphasized the need for action, they also pointed out the lack of reliable and timely data and information as a basis for adaptation. **Research and data** consolidation need to be enhanced for understanding and addressing the impacts of climate change. Technological capacity needs to be built, including also socio-economic, institutional and political knowledge for underpinning technical solutions. The situation of hydro-meteorological and climate impact data is insufficient and often further deteriorating. There are few coordinated and long term monitoring networks or central data and information systems that could serve as a blueprint for the region to put scenarios assessment and adaptation planning on a solid basis. Noteworthy, the region has seen a large training and capacity building effort building on one of the official UNFCCC data consolidation and water planning tools, WEAP[9], e.g. through GIZ, BGR, SEI, World Bank and the GLOWA Jordan River project[10] for individual basins and countries, as well as for a region wide assessment of climate impacts in the water sector and adaptation options with WEAP by Immerzeel et al (2011) – see figures 4a) and b) below

[9] www.weap21.org

[10] www.glowa-jordan-river.org



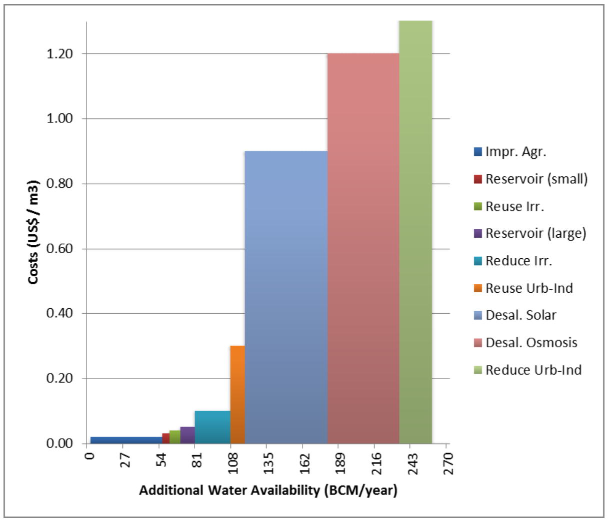


Figure 4a and b

WEAP-based assessment of regional trends in water availabilities, demands and gaps for a medium climate scenario and adaptation options potential and marginal costs according to Immerzeel et al (2011)

Various stakeholders have expressed their interest in applying the new coupled system of the WEAP water planning tool together with the LEAP energy planning tool[11] for a consistent and fully quantitative framework to integrate climate adaptation and mitigation.

By linking up with the new UN-ESCWA / SMHI initiative on ensemble regional climate scenarios for the Arab region[12] within the CORDEX[13] framework, the ACCWaM project engages in a very important regional activity that provides an essential base for climate adaptation, and which deserves wider dissemination in national institutions. We found a "climate scenario fatigue" which is not justified in view of the interesting new results that this initiative will deliver for climate change adaptation. Specifically, this initiative provides

[11] www.worldwaterweek.org/documents/WWW_PDF/2012/Thur/Launching-a-new-analytical/WEAP-LEAP.pdf

[12] www.escwa.un.org/RICCAR

[13] http://wcrp.ipsl.jussieu.fr/SF_RCD_CORDEX.html

targeted climate impact information for water managers and planners, for application in their respective contexts.

Uncertainty, which is a permanent feature of all climate change information, is seen by stakeholders and makers in the region as a major barrier to planning and implementing adaptation. However, uncertainty can be incorporated into water strategies; in many cases climate uncertainties are no reason to delay action – this is particularly true in the MENA region, where (unfortunately) the uncertainties about the direction of precipitation change (on top of temperature increase) are lower than in most other regions of the world – judging by the unanimous decline in precipitation projected by almost all global climate models. Based on our discussions, it will be important to better communicate the appropriate techniques for dealing with uncertainty to water managers and other decision makers. This is needed to ensure both, that climate change is not ignored because it is seen as too vague, but also that uncertainty is reflected sensibly in 'mainstreamed' adaptation activities and measures. For example, **climate risk assessments** can be applied in the water sector, to inform the design and re-design of water strategies. Risk management presents one methodology that explicitly incorporates uncertainty into decision making. Climate risk assessment can also be carried out in ways that explicitly acknowledge the variability of evidence and data upon which assessments are based. For example the methodology used for the UK's national Climate Change Risk Assessment (CCRA) (generally thought to be a leading example) includes a specific category on the 'level of confidence' underpinning each risk. While the climate change situation is quite different, these approaches are also applicable to national water strategies in the MENA region

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Climate effects	Impacts	2030s	2050s	2080s	Threat / opportunity / neutral	Consequences	Pedigree (weight of evidence)	Main sources (SS = Scoping study; SC = Sector report; RR = Sub-national report; CF = CCRA Forum; Other sources see below)	Level of confidence in being correct
Periods of extreme low rainfall	Meteorological and hydrological drought	x	x	x	T	Reduced water supply - **security of supply**; rivers unable to meet **WFD targets**	2	SC = Wade (2004);Goodess et al., 2002; Vidal and Wade, 2008; SS; CF	M

Figure 5
Excerpt of UK CCRA methodology[14]

Other methods for dealing with uncertainty include scenario planning, adaptive management and robust adaptation or resilience strategies (see above). Modelling tools such as WEAP have been designed to explore multiple **scenarios**, reflecting also the wider uncertainties about socio-economic trends, such as increased urbanization as well as

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[14] From ' Method for undertaking the CCRA Part II – Detailed Method for Stage 3: Assess Risk' http://randd.defra.gov.uk/Document.aspx?Document=GA0204_9587_TRP.pdf

technological development. **Adaptive management**, as mentioned earlier, is an iterative management approach that recognizes the importance of learning and incorporating new information over time, aiming for flexibility, as a response to incomplete knowledge and uncertainty.

The ACCWaM project can greatly serve water ministries and related authorities and stakeholders, by providing training and tools on these principles and approaches of mainstreaming adaptation in national strategies. See also the Guidelines in Section 3.

A different way of approaching the problem of uncertainty is to concentrate on win-win opportunities and 'low-regret' options. As stated repeatedly, 'good adaptation' will have many commonalities with 'good IWRM'. Several measures that will help adapting water strategies to future climate also help to improve water management today. Some measures will have positive impacts beyond the water sector, particularly to energy and agriculture, but also for example to biodiversity, economic development, quality of life, etc. Detailed information on future climate impacts is not needed to pursue such win-win opportunities. The figure below provides examples of routine IWRM measures that may also increase system resilience to climate change

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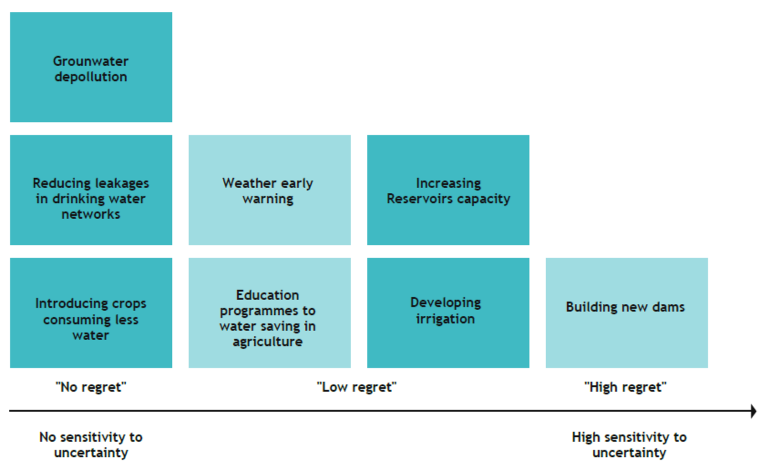


Figure 6
No regret, low regret and high regret measures for climate adaptation (Plan Bleu 2011)

A key point here is that adaptation is first about making systems more resilient to *current* climate variability. It should do so in ways that also prepare water systems for future changes in climate and society and that avoid locking the system in to practices or technical solutions today that will increase vulnerability under future conditions.

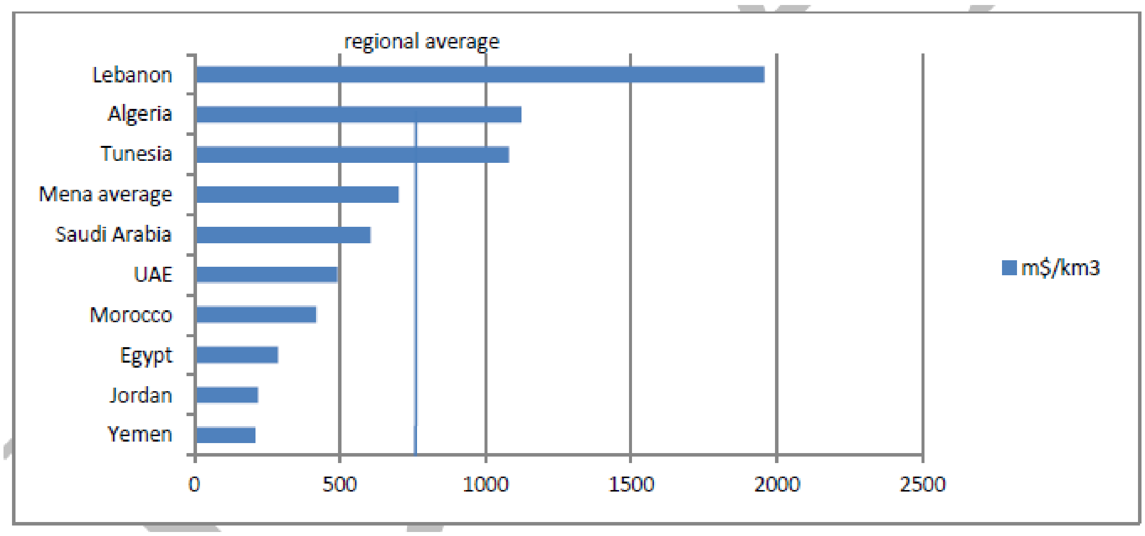
2 National Planning for Climate Change Adaptation in the Water Sector, Potentials and Constraints

2.1 Lebanon

Lebanon is one of the least water (and land) scarce countries in the MENA region, with about 50% of its precipitation becoming (blue[15]) renewable water resource, resulting in a water availability of more than 900 m³ per capita and year (MoEW 2012) – compared to only about 10% and 200 m³ in Jordan. Accordingly Lebanon is currently more challenged by resource management problems than by absolute water scarcity. 67% of its area is agricultural land (compared to 21% of Jordan's and 4% of Egypt's area, World Bank Indicators).

Lebanon has the lowest population growth rate of all MENA countries (0.7% per year, compared to 1.8% in Egypt and 2.4% in Jordan, World Bank 2011) so that its water gap is widening relatively more by climate change driven reductions in water availability than by population driven increases in water demand. Also with a per-capita GDP of 9,200 US$ Lebanon is leading the (non-gulf) MENA countries (World Bank Indicators), which provides more flexibility for investing in adaptation compared to Jordan (4,600 US$) or Egypt (2,700 US$).

Agriculture contributes only about 5% to GDP and 2% to employment (2nd National Communications). With its low dependence on water-intensive agriculture, Lebanon's more diversified economy achieves a higher economic water productivity (more value generated per m³ of water used) than other MENA countries – see figure below.



[15] blue water is the water in rivers, wadis, lakes, reservoirs and groundwater – here distinguished from green water, the plant available soil water directly from rainfall

Figure 7
Economic water productivities of different MENA countries in m$ per km³ of water (World Bank 2011)

Given the diversity of climates (following topography), vegetation zones (Lebanon still has 8% forest cover) and agro-ecological conditions, Lebanon also has a more varied agriculture, and consequently has more adaptation options and with that is probably more resilient to (e.g. climate) shocks. It also has relatively low inter-annual rainfall variability (27%) compared to Jordan (36%) and Egypt (56%) – World Bank 2011 – and hence more reliable natural water supply.

2.1.1. Technical options for climate adaptation in Lebanon

Water demand management is the most important climate adaptation option; there is significant potential for saving water and increasing water productivity in the agricultural and other sectors. In agriculture, which is responsible for 60% of total water demand, options for demand management include e.g. modern irrigation techniques (less flood and sprinkler irrigation), crop and irrigation scheduling, crop choice, reallocation of irrigation water to more productive agro-ecological zones etc. Jordan and to some extent also Egypt provide examples for how to improve agricultural water productivity. However agricultural water management as an adaptation option needs to be tailored to the specific conditions of the different regions in Lebanon, e.g. large mechanized and irrigated farming in Bekaa Valley (see figure 8), strong urban pressures along the coast and Mt. Lebanon, and more diversified agriculture and economic activities in the south (with agriculture often only serving as secondary income opportunity), also reflecting very different levels of land degradation in each region.

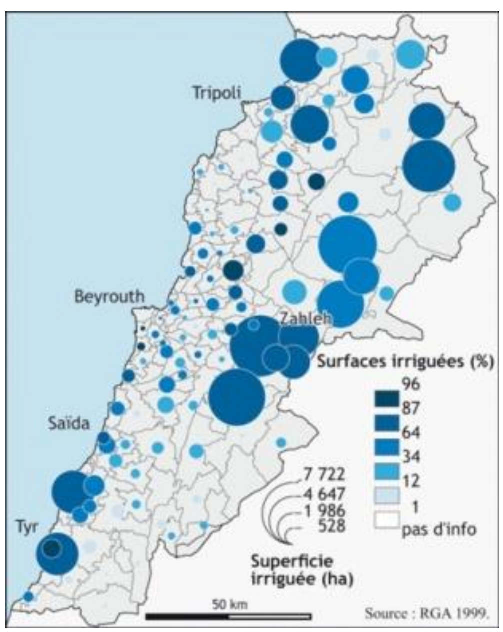
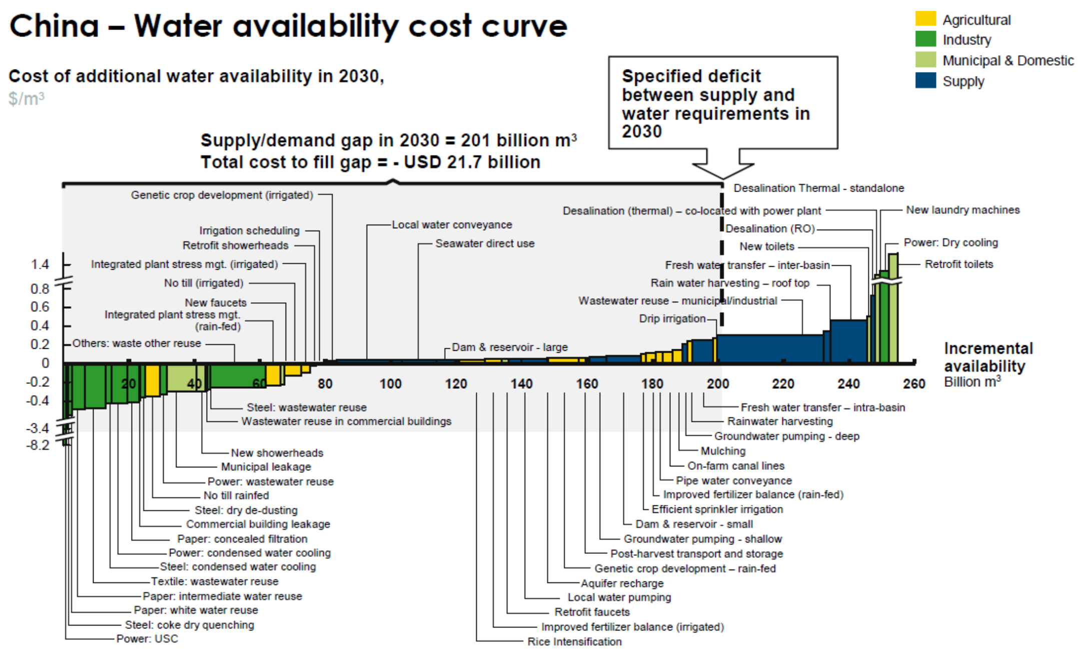


Figure 8
Irrigation concentrated in Bekaa Valley (from FAO 2011)

Another form of demand management is the reduction of very high unaccounted-for-water losses in urban systems, e.g. up to 60% in Beirut. This is particularly important, given the high level of urbanization in Lebanon and the rapidly growing urban water demand. While it is often argued, that such losses can be recovered from the underlying aquifer that is unlikely in the case of the coastal cities in Lebanon because groundwater flows directly to the sea. Illegal abstractions, which are more difficult to address compared to technical losses, also require enforcement of existing regulations.

Demand management is generally also a very cost-effective adaptation option, compared to supply side management, see example of China in Figure 9.



SOURCE: 2030 Water Resources Group

Figure 9

Comparison of high costs per m³ of water, e.g. for desalination and water transfers with low costs or even cost savings for typical demand management measures, e.g. efficient irrigation, municipal leakage, or no till rainfed farming, here for China(Water Resources Group 2010)

In terms of **supply management**, additional water storage is probably the most important adaptation option, followed by wastewater reuse.

Lebanon's special situation, being a narrow country with water quickly running off from the mountains into the sea (about 740 MCM per year are flowing unused to the sea, also from submarine springs) creates a need for additional **water harvesting and storage** structures. Under climate change with increasing variability and less snow water storage (no data is available on actual snow water storage and observed past changes, but the 2nd National Communications projects a 40% reduction in snow coverage with 2 degree warming and a 70% reduction with 4 degree warming), artificial storage needs to be increased even more. An in depth exploration of the full range of storage options from soil (green) water storage to ponds, hillside lakes, reservoirs and subsurface storage and the choice of adapted storage options according to biophysical and socio-economic context is provided by IWMI (2009).

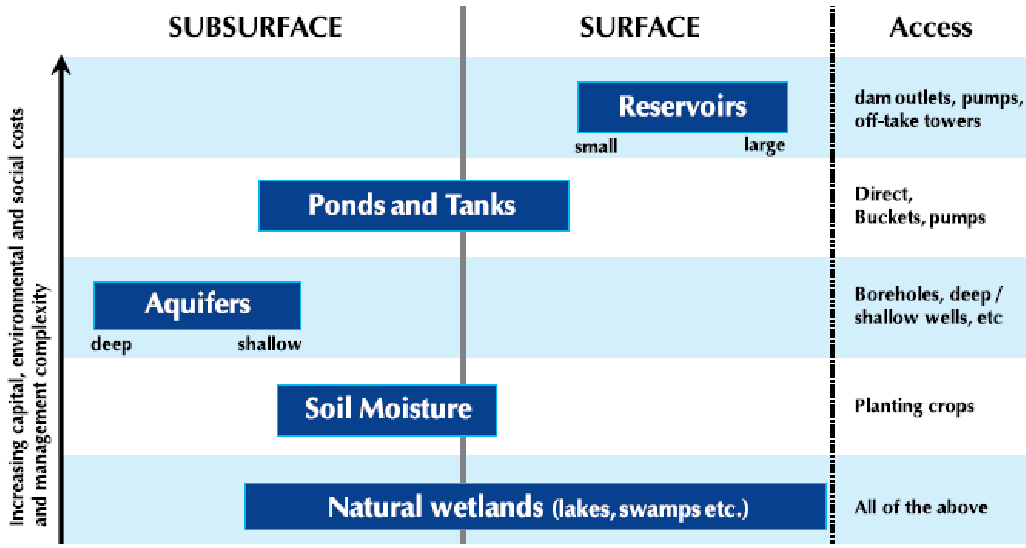


Figure 10

Spectrum of storage options (from to IWMI 2009)

The Ministry of Energy and Water (MoEW) developed in 1999 a 10-year plan to build 17 dams and reservoirs across the country which would capture approximately 650 MCM of water per year, but to date only two dams (Chabrouh and Qaraoun) with about 235 MCM – out of which 45 MCM are actually used – have been completed. If big reservoirs are not feasible to implement, e.g. due to hydro-geological conditions, other storage options from the spectrum listed above need to be tested for their adaptation potential.

Groundwater recharge, or managed aquifer recharge, while more demanding and expensive than surface water storage, has a lot of potential too, in particular by reducing evaporative losses under warmer climate, compared to surface water storage. MoEW (2012) projections show up to 200 MCM of artificial recharge per year by 2020, which is a laudable goal. UNDP is currently conducting a hydro-geological study on optimal locations of artificial recharge schemes.

MoEW expressed interest in a pilot project in the coastal zone on aquifer recharge, which would also result in better protection of aquifers from saltwater intrusion (The 2nd National Communications report that seawater in some locations has already intruded several kilometres inland, see Saadeh 2008) While until now seawater intrusion has primarily been an effect of over-pumping, future sea level rise will further aggravate the situation. Injection wells may also allow recharging of aquifers with sufficiently treated wastewater from cities (70 % of Lebanese population live in the coastal zone and 88% in cities).

Wastewater treatment and reuse is another key supply management measure, which enhances water availability and also water productivity (and recycle nutrients – which otherwise would need to be provided from energy intensive industrial fertilizer). However in Lebanon, currently only about 4-8% of wastewater is treated and none of it is reused (MoEW 2012), so Lebanon has a long way to go to catch up with Jordan or also Egypt. The

Government of Lebanon has built seven wastewater treatment plants (Tripoli; Chekka, Batroun, Jbail, Nabi Younes, West Bekaa, Nabatieh), but these have yet to go online, pending the completion of the corresponding networks and/or service contracts.

Water quality improvements can also be interpreted as supply management, given that many water uses depend on sufficiently high water quality. Besides saltwater intrusion from the sea, another **water quality** risk to groundwater is due to the karstic nature of most of Lebanon's land. It makes aquifers vulnerable to pollution from agro-chemicals and urban wastewater. This strengthens the need for integrated land and water solutions.

Like in all MENA countries, desalination will only become a sustainable adaptation option once it can be based on renewable energy (and the problem of brine disposal is solved).

Like all MENA countries, Lebanon also will actively have to integrate **virtual water imports** (a form of demand management) into a comprehensive water management and climate adaptation strategy. By importing food, irrigation water can be re-allocated to other higher value uses. Lebanon currently imports most of its cereals, cattle feed and livestock products, while local irrigated production concentrates on fruits and vegetables. Rainfed production of cereals and livestock feed is still encouraged by the Ministry of Agriculture. This also requires coordination with other land uses including ecosystem protection for their broader range of services and role in strengthening resilience.

2.1.2 Economic options / enabling conditions for climate adaptation in Lebanon

Agricultural water tariffs need to better reflect increasing scarcity. Currently area-based tariffs provide no economic incentive for water saving or improvement of water productivity. Installation of water meters and volumetric (block) tariffs - as in Jordan – are required.

Underinvestment in agriculture has been identified as key problem, which slows down the implementation of modern water saving techniques (2nd National Communications). So also in the case of Lebanon, climate adaptation funding if becoming available could support agricultural modernization and hence economic development.

2.1.3 Governance option / institutional reform and awareness raising for climate adaptation in Lebanon

MoEW (2012) acknowledges "incomplete implementation of reform law and weak interagency coordination". Part of the problem is – according to MoEW – that the ministry is understaffed and lacks technical capacity. This probably also refers to climate change and climate adaptation expertise.

Lebanon doesn't have water user associations yet to address vulnerability and adaptation at the local level, but local farmers are increasingly involved in decision making about water management alternatives (e.g. in pilot projects on irrigation scheduling).

Water **data** are incomplete, also due the interruption of time series during the civil war, and there is no central monitoring or data and information system in place. The data consolidation and integration activity of the Jordanian Ministry of Water and Irrigation may be of interest in this context. The Lebanese Water Conservation Center has been identified as a potential data host.

MoEW has expressed interest in the use of WEAP, ideally in combination with LEAP[16] for integrated water and energy data consolidation and scenario planning under global change.

2.1.4 Integration of water and other sectors for climate adaptation and mitigation in Lebanon

The relatively large amount of arable land and associated soil water (relative to Jordan, Egypt and the rest of the MENA region) makes improved **land management** particularly important. That includes reductions of land degradation, in order to maintain soil (green) water storage for bridging dryspells (projected to become more frequent under climate change) and accordingly reduce demands for irrigation. The National Reforestation Plan under the Ministry of Environment (MoE), as well as the initiative on Safeguarding and Restoring Lebanon's Woodland Resources and the Lebanon Reforestation Initiative all have the potential to alter the country's hydrology and accordingly its water availability significantly, given the much higher evaporative water demand of trees compared to other vegetation. So there is a need to align forest planning and more generally land use planning with watershed management taking into account the hydrological effects of any land use changes. However currently this is not an issue, because forest fires are consuming forests at a rate that is faster than all afforestation initiatives combined.

Also the lack of land use -, spatial - and urban planning has led to a rapid urban sprawl at the expense of natural landscapes and agricultural land - and the associated soil (green) water resources which are no longer productive in agriculture. Growing cities have reduced agricultural land from 3324 km^2 in 2002 to 2944 km^2 in 2011 (MoE 2012)

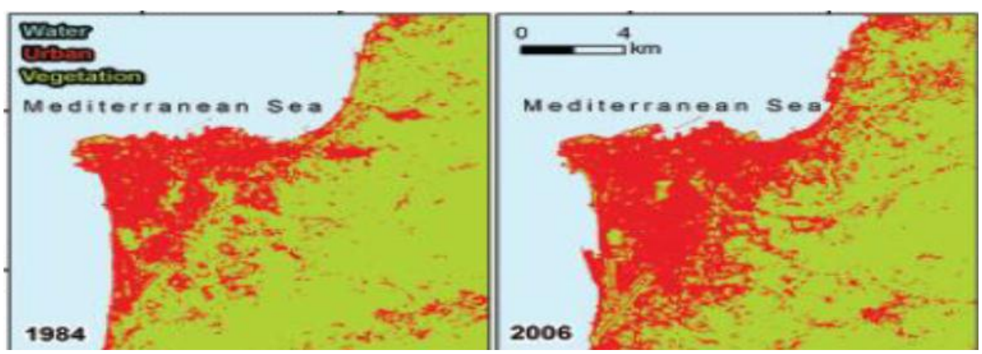


Figure 1
Expansion of Beirut from 1984-2006 (Ghoneim 2009)

The need for **water-energy (climate adaptation-mitigation) integration** becomes obvious when assessing the feasibility and impacts of Lebanon's commitment to increase the share of renewable energy in power generation to 12% by 2020 (see also Biomass Atlas). The associated water demands of that goal, e.g. evaporation from reservoirs for hydropower generation, or transpiration of feedstock plants for bioenergy production would be significant. Generally water intensities of hydropower and bioenergy are many

[16] see e.g. www.worldwaterweek.org/documents/WWW_PDF/2012/Thur/Launching-a-new-analytical/WEAP-LEAP.pdf

times higher per unit of power generated, than for conventional (fossil fuel) power generation (Hoff 2011). Hence it will be important to design new hydropower or bioenergy schemes with water and climate adaptation goals in mind, so they don't compete for scarce water with other uses. Opportunities to do so include e.g. the use of forestry or agricultural residues (e.g. from olive production) for bioenergy production, or the design of multi-functional reservoirs (e.g. hydropower plus irrigation plus recreation) which have higher overall water productivity than mono-functional reservoirs.

Solar water pumps are climate- and energy-smart solutions, which are also becoming economically feasible in some locations, also in view of the fact that highest demands for water pumping (for irrigation) coincide with highest solar insolation in summer.

Climate change is likely to increase energy demand for cooling which already now accounts for 20% of total energy consumption in Lebanon, while at the same time climate change is projected to reduce the hydropower production potential (2nd National Communications). So there is a clear need for integrated adaptation and mitigation planning, e.g. by improving building codes for better isolation and by reducing water demands of power generation.

The lack of a higher-level coordination of water management with other sectors such as land and energy has been identified as a major problem, to be overcome e.g. by way of inter-ministerial committees or other coordinating bodies. At river basin level the Litani River Authority is planning and managing water and agriculture in an integrated manner through an integrated management plan. That could provide a blueprint for other river basins too.

2.1.5 Current water and climate plans and strategies in Lebanon

The central document in water planning is Lebanon's **National Water Sector Strategy**. Unfortunately, many of the goals of the previous water plan (1999-2009, MoEW) were not achieved. Now the new strategy "A right for every citizen, a resource for the whole country" (approved in March 2012) projects the water sector development until 2020. There is no mainstreaming of climate change in this strategy, only very brief mentioning of the need to compile relevant data. Out of a total investment budget of US$ 2.45 billion, 5 million are foreseen to "improve / refine climate change knowledge". The term "climate change" appears 6 times on > 100 pages. The only brief section of the strategy that deals with improved climate change knowledge suggests that with a future decrease in precipitation between 10 and 50% and an increase in evapotranspiration between 3% and 36%, surface runoff would increase (no estimate of the amount provided). This counter-intuitive suggestion is not founded on scientific evidence as available from regional climate and impact models.

While the strategy identifies the limited focus on demand management as a shortcoming of Lebanon's water sector, it is not prioritized in the new strategy (until 2020) either. Demand management measures are focused on technical measures, e.g. under "reductions in unaccounted for water" only leakage reduction is mentioned, while informal discussions with the stakeholders emphasized the need to reduce illegal abstractions. The section on capital expenditure requirements doesn't mention demand management at all.

So the document largely remains a 'wish list', and vulnerability to climate change in the water sector may not be reduced as much as would be required. There may be support for a new Lebanese IWRM plan that would tackle more explicitly climate change adaptation (Grobicki 2011). Bou-Zeid and El-Fadel (2002) and Osman-Elshasa (2010) have identified adaptation measures related to water resources in Lebanon which address also policy change:

Adaptation measure	Potential benefit	Best uses
Conservation	Curbs water demand increase	Domestic, industrial, agricultural demand reduction
Use of surplus winter runoff	Collectable runoff can constitute up to 10% of rainfall	Irrigation, aquifer recharge
Wastewater reclamation	All collected wastewater can be reused	Irrigation, aquifer recharge
Seawater/brackish water desalination	Unlimited water supply	Domestic, industrial
Rainfall enhancement by seeding clouds with silver iodide crystals	Can increase precipitation by up to 15% in arid regions	Domestic, industrial irrigation, aquifer recharge
Use of submarine springs	Submarine springs with significant flows are located along Lebanese coastal waters	Domestic, industrial, agricultural use, aquifer recharge

Lebanon's **1st First National Communications** to the UNFCCC was published in 1999, and the 2nd National Communications in 2011. They are brief and remain rather general on water, stating the obvious. Their approach follows the traditional top-down sequence from climate change scenarios (based on the PRECIS regional climate model) to impacts, not taking on board any integrated or resilience-based approaches. The Second National Communications developed climate change scenarios with vulnerability and adaptation assessments and lists some adaptation measures for the water sector (MOE SNC):

1) the **protection of groundwater** from salinization in coastal areas;
2) the implementation of water **demand side management strategies** to reduce water demand in the domestic, industrial and agriculture sectors;
3) the development of **watershed management plans**; and
4) the implementation of **pilot initiatives** to demonstrate the feasibility of alternative sources of water supply and develop necessary standards and guidelines.

The 3rd National Communications will be prepared soon, so now is a good point in time to introduce new concepts, innovations and a stronger water focus.

National partners had mentioned that Lebanon also has submitted to UNFCCC a National Climate Adaptation Strategy. If this was the case it would make another important entry point for mainstreaming of climate adaptation also in the water sector.

The **National Energy Efficiency Action Plan** lists 50MW of hydro- and micro-hydro power projected to be established by 2015, which would cover 9% of power production. It will be important to assess the implications of hydropower (and possibly bioenergy) production for water availability as competing with other water demands, in particular under climate change and its reduced water availability and reliability.

<u>Other relevant Lebanese plans and strategies</u>:

While Lebanon hasn't set a concrete goals for adaptation to the climate change, it set a mitigation goal (at COP15) to increase the contribution of renewable energy to 12%.

- Stratégie de Développement Agricole du Liban (2004), Ministry of Agriculture
- Green Plan, which was already initiated in 1963, addressing e.g. land reclamation, terracing and hill lakes, developed hundreds of small storage ponds with a total capacity of around 4 MCM – related to that Hilly Areas Sustainable Agriculture Development (HASAD) within Ministry of Agriculture. The Green Plan contains many relevant measures that need to be mainstreamed for climate change adaptation.
- Hydropower Master Plan
- Policy Paper for the Electricity Sector (MoEW 2010)
- Strategic Environmental Assessment, Ministry of Environment
- National Bioenergy Assessment
- New Energy Plan (Lebanese Center for Energy Conservation)

Lebanon's adaptation focus in the National Economic and Environmental Development Studies Project was on the agricultural sector (Farajallah et al 2011).

2.1.6 Institutions consulted and additional potentially relevant institutions in Lebanon

- Ministry of Energy and Water
- Ministry of Agriculture
- Ministry of Environment / UNDP
- American University of Beirut (AUB)

Additional potentially relevant institutions

- Lebanese Agricultural Research Institute (focus on climate change)
- Lebanese Center for Water and Wastewater Management
- Lebanese Water Conservation Center
- Lebanese Center for Energy Conservation Projects
- Litani River Authority for integrated river basin planning

2.1.7 Pilot project in Lebanon

The planned climate adaptation pilot project for preventing saltwater intrusion into coastal aquifers through injection wells is a good example of the type of win-win solutions that not only address the effects of climate change, but also other pressures on the water system – such as over-pumping. It would have to be embedded in a more comprehensive strategy that is not limited to technical solutions, but also tackles institutional aspects such as control of illegal abstractions and enforcement of existing laws and regulations, which is at least as important as addressing the technological challenges. To date, climate change and associated sea level rise still have a relatively minor impact on seawater intrusion into coastal aquifers, compared to the effects of over-pumping, see also the project of the

American University of Beirut (AUB) on "Climate Change and Saltwater Intrusion along the Eastern Mediterranean: Socioeconomic Vulnerability"

2.1.8 Recommendations for Lebanon

Lebanon is in a relatively privileged water-position in the MENA region still and should make any effort to maintain that advantage through pro-active adaptation, in order to maintain the degree of freedom it currently has, rather than waiting until expensive, re-active and non-sustainable emergency responses become unavoidable.

Demand management is generally a cost-effective win-win option and must have highest priority in climate adaptation in the water sector. That includes the increase in water productivity, reduction of technical losses and of illegal abstractions. Economic incentives for demand management (e.g. agricultural water tariffs) can be improved.

On the supply side, the generation of additional water storage is one of the most important measures in Lebanon, given the large losses of water to the sea, the increasing climate variability and the loss of snow water storage with global warming.

Water quality management is a key measure to avoid losses of water availability, once critical pollution levels are exceeded. That includes protection of groundwater from seawater intrusion, wastewater treatment and reuse (which is largely underutilized still) and improved agricultural water management.

Lebanon is likely to gain the highest benefits of all MENA countries from improved land management. True Integrated Water Resources Management ("coordinated development and management of water, land and related resources" – GWP 2000) has large potential, given Lebanon's relatively favourable agro-ecological situation.

Also in hydropower potential, Lebanon is in a better position than most MENA countries, but its development needs to be fully embedded in the overall national water planning strategy, for avoiding negative impacts on other water-demanding sectors. Here an integrated planning tool such as WEAP-LEAP can help to identify and quantify trade-offs and integrated solutions.

The 3rd National Communications that Lebanon will prepare soon, are a good opportunity to introduce new concepts, innovations and a stronger water focus.

2.2 Jordan

Jordan's population growth rate (2.4% according to World Bank 2011) is one of the highest in the region and in fact in the world, which translate into a doubling of population in about 30 years.

Jordan is at the extreme end of water scarcity (when expressed as water availability per capita or demand vs. supply), even within the MENA region – see comparison in figure 12 below with Egypt and Lebanon. The perception of most stakeholders in our discussion was that other pressures have been increasing scarcity much more rapidly than climate change, and that Jordan is already employing about every possible water management measure, so that there is little room/need for additional climate change adaptation measures in the foreseeable future – when considering a medium-term planning horizon until say 2020 or 2030. Stakeholders consulted consider changes in water availability in that time frame to remain within the current variability ("we have been adapting to climate variability for the past 1000 years").

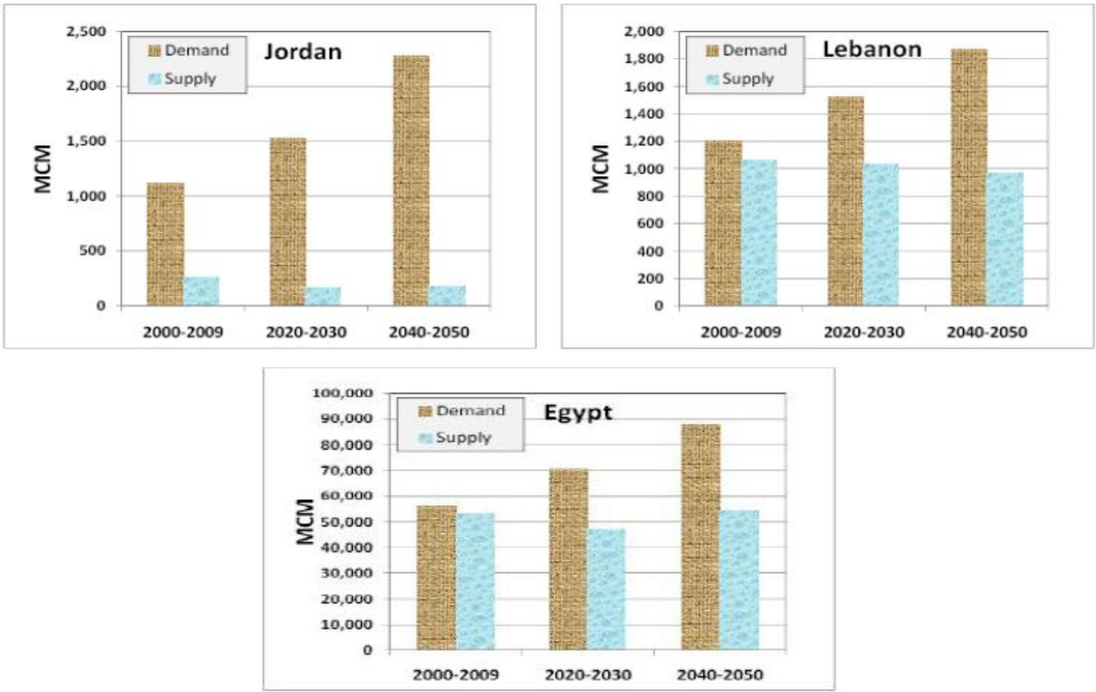


Figure 12
Demand-supply relations for current and future situation in Jordan, Lebanon Egypt, World Bank 2011

Fortunately, most current water management options also prepare for further reduced water availability under climate change. An example for projected decrease in water availability is provided by Menzel et al (2007), who calculated in the context of the GLOWA Jordan River project a 25% reduction of annual water availability for a medium change climate scenario which assumes lower increase in greenhouse gas emissions than currently observed.

2.2.1. Technical options for climate adaptation in Jordan

Demand management remains the most important adaptation option to climate change. In agriculture, the largest water user in Jordan, water productivity can still be improved, e.g. through more drip irrigation, despite the leading role that Jordan already has in advanced drip irrigation in the MENA region. Note that there are potential conflicts between drip irrigation and wastewater reuse, e.g. clogging of dripping holes in pipes. The difficulty in reducing illegal abstractions in cities as well as in agriculture points at difficulties in enforcing existing regulations. That is particularly critical for overexploitation of groundwater in the highlands, which would require control over the small number of large – often absentee - farmers with high water use. Participatory activities towards reducing groundwater overexploitation by the Highland Water Forum demonstrate the need to differentiate between the different types of users, e.g. small vs. large water users and local vs. absentee farmers.

Despite Jordan's extreme water scarcity, per capita urban water use is still higher than in some European cities. Also unaccounted for water is still very high in the cities – up to 50% in Amman. Stakeholders consider technical loss reduction to be easier to achieve than the reduction of illegal use.

The recent private sector engagement in urban water supply bears the risk of diluting the important water saving message by implying that privatization will guarantee unlimited access to water.

Given that Jordan's food supply relies to about 75% on imported virtual water, these imports with agricultural commodities will remain the most important demand management measure in quantitative terms (see also virtual water imports in figure 17). Consequently, Jordan's water strategy requests that "Jordan must remove tariffs on imported crops". It is not clear however, in which way virtual water imports affect the overall vulnerability of Jordan's water and food security. While a geographically more distributed resource base in principle reduces drought risks, imports expose Jordan at the same time to the world market price fluctuations and the possibility of major exporters to reduce or stop exporting in case of drought, scarcity or other shock.

There are limited opportunities for **supply side management** in Jordan, given the full exploitation / overexploitation of available surface and groundwater resources. The main supply side options currently implemented and projected for future national water management, are the transfers of i) fossil groundwater from the Disi Aquifer (under construction) and ii) of desalinated seawater from the Red Sea (planned) to Amman and beyond. As a general rule, building a country's water system on a variety of different (and distributed) solutions is likely to be a more resilient adaptation option to future disturbances or shocks, compared to a single centralized large-scale solution. Also pumping of water across such large distances and elevation gradients – as from near the Dead Sea (below sea level) to Amman (up to 1000 m above sea level) for municipal demands requires large amounts of energy (comparable to desalinating the same amount of water).

Wastewater reuse provides a growing contribution to Jordan's water supply – higher than in most other countries of the MENA region. It not only recycles water but also nutrients, which otherwise would have to be provided with additional inputs of energy-intensive fertilizer. Currently the central As Samra treatment plant for the Amman area is upgraded, and additional wastewater treatment and reuse capacity is being developed for the Zarqa basin and Jordan Valley (eventually expanding wastewater reuse to the northern Jordan Valley), freeing up freshwater for municipal and other higher value uses. Early treatment of industrial and other wastewater before it mixes with other water has been recognized as a priority measure to avoid pollution-related losses in usable water. Decentralized wastewater treatment in rural and semi-urban settings has been identified as an important addition to the existing central treatment plants, for its flexibility and specific treatment of different wastewaters, and eventually also for more resilient climate change adaptation, e.g. by the SMART project[17].

Additional brackish water can be (and in the Jordan Valley is already) used in bio-saline agriculture if salt resistant crops are selected – see also proposed adaptation project in

[17] http://www.iwrm-smart2.org/

Jordan Valley in section 2.2.7. Crop choice and crop breeding – also for drought resistance - are important adaptation options in the agricultural sector.

While **water storage** in principle is an important adaptation option to increasing climate variability, there is very limited potential in Jordan for additional storage. In some cases existing storage volume cannot be filled with the (shrinking) available water resources – as for example in the Yarmuk basin, where the Al-Wehda / Unity Dam doesn't fill up. Here as well as in the Jordan river basin, upstream riparians have already diminished flows much more than climate change ever could.

In this situation, artificial groundwater recharge is the only under-utilized storage option. It avoids evaporative losses and hence becomes even more important under higher temperatures. Artificial storage is currently planned for pilot projects in the highlands.

Small-scale rainwater harvesting and storage structures are mandatory, as part of Jordan's building code, but the existing legislation is not sufficiently enforced.

2.2.2 Economic options / enabling conditions for climate adaptation in Jordan

Economic water productivity can be increased if water is reallocated (possibly also through water markets) to higher value uses, such as tourism (example Dead Sea) and other services sectors that are not very water intensive. This diversification and reduced economic dependence on water resources is not only a strategy for climate change adaptation, but also for diversification and resilience building– if embedded in a consistent land use, food security, and development strategy. The establishment of water markets as a tool for allocating water to highest economic productivity is insufficiently established, lacking a sound legal framework. Consequently, some farmers simply sell water for a much higher price than the very low price for which they received the water.

2.2.3 Governance options / institutional reform and awareness-raising for climate change adaptation in Jordan

Jordan has initiated a process of institutional reform in the water sector, e.g. decentralization, establishment of water user associations and on-going restructuring within the Ministry of Water and Irrigation (MWI) in the context of the Institutional Support and Strategy Program (ISSP) for the water sector. These initiatives provide a window of opportunity for more integrated (e.g. water-energy and water-land) approaches and for mainstreaming climate change adaptation into water planning (coordinated in the MWI by the Department for Management of Water Resources).

Cross-cutting programs may help to achieve the required integration across sectors, such as the program on water quality, health protection, and food security, which is to enhance Jordan's capacity to adapt to climate change, and which is supported by UNDP, WHO, FAO, UNESCO, and the national ministries of water and irrigation, environment, health, agriculture, and education. The experience with a new cross-cutting ministry for mega-projects however was less encouraging, it was dissolved again.

The **integrated water data and information system** for consistent and continuous data, which is currently developed at MWI is an excellent response to the information needs of improved water management under climate change. It includes climate, hydrological surface water, groundwater water, and water quality data, and integrates monitoring, telemetry and central data management in the ministry. For climate change adaptation it will be important to analyse time series for climate change signals and continuously integrate any new information from science for adaptive management (including e.g. the new regional ensemble climate scenarios from the UN ESCWA / SMHI initiative).

Use WEAP opportunity, which is not only a participatory planning tool, but at the same time consistently integrates relevant data and time-series.

Jordan's water- and climate-related data are currently consolidated and analysed for water planning in WEAP. WEAP models have been developed over the past years (with the help of GIZ/BGR, SEI and the GLOWA Jordan River project) for all major river basins of Jordan, in order to test various climate scenarios and climate adaptation measures for their system-wide effects. These models are now merged into one national WEAP model. WEAP has also been used in Jordan's National Communications (in line with UNFCCC guidelines). The Jordanian water data and information system and national WEAP model could become a blueprint for other MENA countries as an integrated climate change adaptation framework. Coupling to other applications such as ModFlow (groundwater), Mabia (irrigation), and MYWAS (cost-benefit analysis) in Jordan and various other MENA countries has already made WEAP a de-facto standard planning tool for the region.

Most recently the WEAP water planning tool has also been coupled to LEAP[18], an energy planning tool, so the two can now be used for integrated water-energy planning, e.g. identifying and quantifying negative externalities from mono-sectoral planning and potential synergies from integrated approaches.

Climate change is receiving considerable attention in Jordan and hence provides an opportunity to initiate or accelerate much needed further technological improvements, demand management and institutional reform. Going beyond these typical IWRM measures, additional climate risks and resulting vulnerabilities need to be communicated to policy and decision makers, such as those associated with droughts and other extremes. These extremes may materialize much faster than projected changes in average water availability and are likely to overtax existing coping mechanisms. Careful assessments need to determine the limits of adaptation by means of conventional measures, and possibly required further reaching transformative changes, in response to mounting climate pressures.

Jordan in many respects is a pioneer in the region, simply because of its already pressing water scarcity. So solutions from Jordan will be of interest for the other countries, when these follow the same development path in terms of urgency and responses to water stress.

2.2.4 Integration of water and other sectors for climate adaptation and mitigation in Jordan

Integration of water and energy (climate adaptation and mitigation) holds significant potential in Jordan for increasing overall resource productivity and averting or delaying crises. While water is projected to be the most impacted sector from climate change, at the same time, 15% of Jordan's energy demands – and related greenhouse gas emissions – are from the water sector (desalination would increase that further). Moreover some of the proposed future energy pathways (e.g. nuclear or mining of oil schists) would be very water intensive. Accordingly, any reductions in wastage and improvement in water productivity

[18] www.sei-international.org/mediamanager/documents/Publications/Climate/leap.pdf

also provide co-benefits in the energy sector – and vice versa. Integrated water and energy assessments will have to include future climate change effects and mitigation goals (e.g. through renewable energy).

Given the good progress Jordan is making with addressing the water - energy nexus (in particular energy-smart water pumping and energy recovery from wastewater treatment plants – the As Samra plant is almost energy self-sufficient) it could become a role model for the MENA region for integrated climate and water management solutions. In Jordan, the emphasis on renewable energy seems to be increasing, also relative to the ambitions for centralized nuclear power production – which could significantly increase vulnerability of Jordan's water and energy systems (see also Kiswany 2012). Continuity and long-term planning are essential for climate adaptation (and mitigation), but these are currently subject to frequent changes of ministers and other high level officials and associated priorities.

Integration of water and land management holds significant potential also for addressing additional climate pressures, e.g. in terms of water-smart spatial and urban planning and land use zoning, improved soil management for green water storage etc. Reducing land degradation / desertification and rehabilitating land holds co-benefits in terms of soil water storage (important for bridging dry spells) and also for C-storage (integration of adaptation and mitigation).

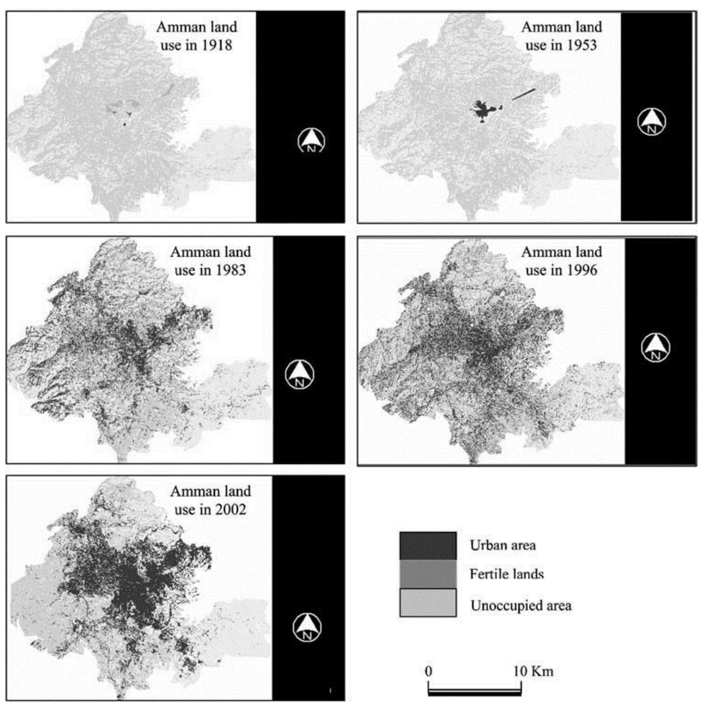


Figure 13
Rapid growth of Amman over the past century – mostly at the cost of good agricultural (even rainfed) land, which has drastically reduced the productivity of associated green water, which is lost for biomass production

2.2.5 Current water and climate plans and strategies in Jordan

The central document in water planning is **Jordan's Water Strategy** 2008-2022 – Water for Life. After many years of gradually introducing stricter water laws, e.g. prohibiting further exploitation of depleted groundwater basins, monitoring of groundwater use, or introducing block tariffs on water use, Jordan's Water Strategy has recently been updated. When comparing the new 2012 version with that from 2008, climate change is now receiving much stronger attention. "The nation has to be prepared for additional water stress caused by climate change" is listed as a core principle of the strategy, and adaptation to climatic change is listed as a "specific targeted objective". However proposed top-down measures at national level do not automatically reduce vulnerability to climate change in the respective local context.

The strategy contains a long wish-list of measures, only a few of which have been implemented so far. The strategy has a strong emphasis on demand management, which is key for adaptation to climate change and increasing water scarcity, given the full (and over-) exploitation of all available water resources in Jordan, requesting e.g.:

- "irrigated agriculture in the highlands will need to be capped"
- "encourage farmers to use modern and efficient irrigation techniques"
- "reduce evaporative losses through closed pipes"
- "transferrable water rights"
- "optimizing water allocations as per the National Water Master Plan", which can help to improve economic water productivity.

But the strategy also prioritizes the few remaining supply side measures, e.g.

- "use of grey water"
- "use of rainwater harvesting is encouraged"

The strategy points out, how water should be linked to other sectors, in particular agriculture and land management, primarily for improving water quality:

- "land use licensing …in order to minimize negative impacts on groundwater and surface water"
- "coherent and inter-sector spatial planning, including urban and peri-urban development need to be applied"

Beyond land use and spatial planning, water quality aspects also need to be recognized as important measures to enhance or at least maintain water availability (differentiated quality requirements for different uses) and improve water productivity.

Also links between water and energy (and food) are addressed in the National Water Strategy:

- "water, a scarce resource…needs to be…linked to other crucial resources such as energy"
- "increase energy efficiency of the water supply and distribution systems and harness alternative energy sources to provide 20% of the power required to pump water"

- “wastewater treatment technologies with due consideration…in energy consumption”
- ”encourage power generation from sludge”

The strategy further addresses the need to improve and better manage water-related data and information (a pre-requisite for planned adaptation), suggesting to:

- “establish a water research unit within the ministry” and a
- “water information system at the ministry of water and irrigation” as well as to
- “set up a national water training centre”

It proposes an “institutional reform in Jordan’s water strategy” for example pointing out the “need to collaborate among all concerned ministries”. It hints at the need for institutional adaptation by pointing out that “there exists an overlap of responsibilities with other ministries” and the need to “clarify the responsibilities of the different ministries involved in the water sector”.

It provides an entry point for mainstreaming climate change adaptation into overall development planning: “The NWMP should link between water sector planning and national development planning”

The **investment or action plan** for implementing the strategy (MWI 2012) doesn’t include any specific climate change adaptation measures (mentioned once in the document). However this plan is currently updated, in line with the Institutional Support and Strengthening Program (ISSP) for the water sector. This program is expected to lead to a restructuring of the Ministry of Water and Irrigation and as with any new structure, there is a window of opportunity to introduce new concepts and innovations for mainstreaming climate change adaptation.

The **National Water Master Plan** which was developed with GTZ support, published in 2004 is currently being revised and streamlined, with WEAP as a central planning tool. Existing WEAP models which have been developed for individual basins in Jordan are currently integrated in one national WEAP system.

The **1st National Communications** to the UNFCCC were published in 1997, the 2nd National Communications in 2009. They mainly contain a description of the knowledge (and limitations) along the well-known chain from global to regional climate models, and further to impact models, vulnerability and adaptation assessments for the water sector (also using WEAP), the agricultural sector and other sectors. So they list some of the important water management measures, but without identifying innovative and integrated measures. With the 3rd communications now under preparation, there is an opportunity to fill that gap. In particular it will be important to also develop an adaptation action plan.

The Ministry of Environment also coordinates the development of a **climate change policy**, which is integrating perspectives from a wide range of other ministries and stakeholders. This effort is being led by the national climate change committee. Again, there is scope for closer integration with water planning

2.2.6 Institutions consulted in Jordan

- Ministry of Water and Irrigation
- GIZ

- BGR
- Ministry of Environment
- UN Joint Program (Adaptation to Climate Change to Sustain Jordan MDG Achievements)
- French Embassy in Jordan
- Friends of the Earth Middle East (FoEME)

2.2.7 Pilot project in Jordan

The proposed pilot project will focus on sustaining groundwater resources in the Azraq basin, which are projected to diminish under climate change through a combination of improved recharge and reduced abstraction. This is to be achieved by: i) artificial recharge using dams for capturing and infiltrating excess water from flash floods, and ii) providing farmers with less water-intensive income alternative, i.e. energy farming. Given that groundwater is the main (and critically overexploited) irrigation water source in much of Jordan, and the successful participatory approach through the Highland Water Forum, this pilot project can demonstrate the feasibility of improved groundwater management and knowledge and capacity building for later outscaling and upscaling to other aquifers. Additionally assessments will be required for future groundwater recharge under climate change – e.g. based on new UN-ESCWA / SMHI regional ensemble climate scenarios.

Additional suggestions by Jordanian stakeholders for climate change adaptation projects were:

- water harvesting and storage in the Badia region, to tap some of those 90% of precipitation that become green water which Jordan's national water plan considers not to be available for water supply. This could build on the model of the GIZ pilot project, including aquifer storage
- desalination of brackish water or use of brackish water for bio-saline agriculture in the Jordan Valley

2.2.8 Recommendations for Jordan

Even more so than in Lebanon, supply side options are largely exhausted and accordingly demand management must have highest priority in climate change adaptation in the water sector, through increased water productivity and reduction of technical losses and of illegal abstractions. Water markets as tools for increasing water productivity are not yet fully established

Very few opportunities remain on the supply side, such as grey water reuse, rainwater harvesting and aquifer storage. Water quality management remains essential to avoid further reductions in water availability. Virtual water imports as the main adaptation option to increasing water scarcity has to be fully integrated with water and land planning.

Despite further advanced water strategies and plans, also in terms of climate adaptation, compared to other MENA countries, there is still a significant implementation deficit, e.g. when it comes to reducing illegal abstractions.

Jordan can turn its disadvantage of being most pressed in terms of water scarcity into an advantage, if it becomes a role model in the MENA region in adaptation, providing alternative and integrated water and energy opportunities, which are much more cost effective than those development pathways that the Gulf countries are now proposing. Jordan's advanced position in adapting to water scarcity is illustrated e.g. by

- its high level of wastewater reuse,
- energy efficiency improvements in water pumping
- energy recovery in wastewater treatment ("triple win")
- water data integration and integrated scenario planning (using WEAP) in the MWI

Windows of opportunity for mainstreaming climate change adaptation exist, e.g. through institutional reforms on-going in the water sector and upcoming revisions of the:

- investment or action plan for implementing the national water strategy,
- National Water Master Plan,
- 3rd National Communications to the UNFCCC

2.3 Egypt

A population growth rate of 1.8% (World Bank 2011) translates into 1.5 million additional citizens every year, of which 97% live on 4% of Egypt's land (Nile valley and delta). The resulting high population densities in particular in cities causes additional exposure and vulnerability to climate change.

The per capita GDP (US$ 2700, World Bank Indicators) is lower than in Lebanon and Jordan, while the dependency on agriculture is higher (about 15% of GDP and 30% of workforce, World Bank 2011), which limits manoeuvring space for adaptation. Moreover Egypt has only one major renewable source of water, the river Nile, making it very dependent.

On top of the rapidly growing demand for water due to population growth and economic development, there is additional pressure from i) inefficiencies in the water system and ii) decreasing water availability from the source areas of the Nile – which is not primarily a climate change effect, but caused by land use change, new dams and withdrawals, in particular in Ethiopia which contributes about 85% of Egypt's Nile water resources. According to the national water resources plan, Egypt's "water resources system has reached its limit of what it can support". Hence demand management must have the highest priority in adaptation planning.

Given Egypt's almost complete dependency on water inflow from upstream, **trans-boundary collaboration** is essential, in particular for increasing the basin's green and blue water productivity and total benefits derived. This includes sharing of knowledge and technologies with Nile basin riparians. Opportunities are also in moving water storage and water intensive food or energy production further upstream. If collaborative agreements can be reached, more storage could be realized further upstream where evaporative losses are lower. Lower evaporative demands upstream can also increase total agricultural water productivity if irrigation water and irrigated production are shifted to upstream locations. However, despite Egypt's climatic disadvantage, it still has higher agricultural water productivity compared to Sudan and Ethiopia. Hence sharing of knowledge and technologies should be key elements of trans-boundary collaboration (Hoff et al 2012). A lack of collaboration is illustrated by the fact that the Nile Forecast Center in Cairo has to rely on remote sensing (satellite) rainfall data for calculating inflows into Lake Nasser and for deriving reservoir management rules, because it lacks access to streamflow data from Ethiopia or Sudan. The 2nd National Communications confirm that "there is high potential for trans-boundary cooperation rather than conflict" and propose improved "exchange of data and information between Nile Basin countries". Egyptian experts working in upstream countries could facilitate knowledge transfer and forge improved relationships.

2.3.1. Technical options for climate adaptation in Egypt

Like in Lebanon and Jordan, demand management must have highest priority. It is particularly important in agriculture, which is almost completely irrigated, requiring more than 80% of all water (OOC 2011). Current inefficiencies in particular water intensive flood irrigation in combination with increasing future irrigation demand due to climate change and the lack of supply side options, leave demand management as the only major adaptation option. Note however, that agricultural water productivity in Egypt is already higher than in all other MENA countries. Egypt's irrigated agriculture produces on average more than 3000 kcal per m^3 of water consumed, while most other MENA countries produce about 1000 – 2000 kcal (Gerten et al 2011).

While underground water losses are likely to stay within the closed system of the Nile River and its underlying aquifer available for downstream reuse, any evaporation is a true loss from the system hence reducing overall water productivity and needs to be minimized. Opportunities for agricultural demand management include closed systems instead of open canals, drip irrigation, and precision agriculture. Also any measures to increase yields (e.g. crop breeding, changed sowing dates or fertilization) and/or to reduce crop losses from pests or other calamities simultaneously reduce unproductive water flows and increase overall water productivity.

Water productivity improvements are closely linked with higher yields, so there are co-benefits with improved land use – with agricultural land also being scarce in Egypt. Demand management in the Nile valley can set free additional water for horizontal expansion of cultivated land into the desert. These agricultural expansions are currently depleting Egypt's strategic water resource, i.e. fossil groundwater, reducing the degrees of freedom in future water management and likely causing a loss in future resilience.

However, sustaining these horizontal expansions with water from the Nile – doesn't seem to be sustainable in the long run either, given the growing pressure on water resources throughout the Nile basin - see for example Toshka Lakes in the figure below, which have lost most of their inflow from the Nile

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Figure 15
Largely depleted Toshka Lakes in June 2012 (Lake Nasser on the right)

Water quality improvements are most urgent, given the downstream location of Egypt and in particular the Nile Valley, where most water is reused

Supply side management: within Egypt, the potential for making additional water resources available is very limited, unless seawater desalination becomes economically viable. There may be some potential for rainwater harvesting in the north and Sinai.

Water quality improvements of upstream effluents improve opportunities for water reuse downstream, and hence translate into improvements in water availability in the closed Nile basin system. In particular in the Nile delta water reuse is severely compromised by pathogens, industrial pollutants, pesticide, and fertilizer from upstream sources (less than half of Egypt's households and only 30% of rural households are connected to a sewerage system, OOC 2011). Upstream water quality improvements (as well as water savings) pay back several times through multiple re-use downstream.

Existing wastewater quality standards are not always enforced, hence adaptation via water quality improvements critically hinges on institutional solutions in addition to technical solutions

Another water quality problem is salinity in particular from seawater intrusion in the Nile delta. Being very flat and at low elevation (partially now already below sea level) this region is more vulnerable to sea level rise and associated flooding and seawater intrusion than Lebanon's coast. Currently sea level rises relative to the land (for a combination of reasons) between 1 and 2.3 mm per year (2nd National Communications). Intensive rice irrigation in the coastal zone can help to maintain the freshwater hydraulic head and prevent seawater intrusion (Sherif 2003). This effect has to be taken into account when introducing less water intensive rice cultivars or dry rice (which also serves climate mitigation through reduced greenhouse gas emissions).

The potential for soft coastal protection ("living shorelines") is analysed by the SEI / UNEP / ECRI project on "Adaptation to Climate Change in the Nile Delta through Integrated Coastal Zone Management

Egypt is one of the largest food importers and hence **net importer of virtual water**, which is implicitly is also a form of water management – like the recent investments in agricultural land abroad, e.g. in Ethiopia. Currently Egypt's agriculture covers about 60% of the country's food needs (OOC 2011). With further population growth and economic development in combination with growing water constraints, this self-sufficiency level is likely to shrink.

Governmental policies aiming at increased wheat production, which has low economic water productivity, are also part Egypt's food security strategy. The conflicting goals of maintaining high levels of food self-sufficiency vs. increasing water productivity may be reconciled to some extent through crop rotation. Different stakeholders had different views on the need to maintain a certain domestic production level vs. relying more on imports. Again, local vulnerability e.g. to climate extremes and water scarcity needs to be balanced against vulnerability associated with stronger dependency on world markets.

2.3.2 Economic options / enabling conditions for climate adaptation in Egypt

The MWRI has identified irrigation water pricing as an instrument to reduce demand and increase overall **water productivity**. However that needs to be embedded in a wider development strategy to avoid increasing the vulnerability of poor farmers.

Besides improved agricultural practices and water pricing, another means for increasing economic water productivity and at the same time diversify income opportunities (likely to increase resilience) is further processing of primary goods such as crops and cotton, to add value along the supply chains (e.g. crops into food products and cotton into clothing). There are constraints however in terms of available technologies and competiveness on world markets and the required training of farmers and other rural dwellers.

While not part of the stakeholder consultations in July 2012 it may also be of interest to compare the costs of different adaptation options, per m^3 of water saved or additional m^3 of water provided. Immerzeel et al (2011) compared different supply and demand management options for Egypt. They find that agricultural demand management and water reuse in agriculture are at least an order of magnitude cheaper per m^3 of water than desalination.

Measure	Cost (US$/m^3)
Improved agricultural practice (including crop varieties)	0.02
Expanding reservoir capacity (small scale)	0.03
Increased reuse of irrigated agriculture	0.04
Expanding reservoir capacity (large scale)	0.05
Reduce irrigated areas	0.10
Increased reuse of water from domestic and industry	0.30
Desalination by means of using solar energy	0.90
Desalination by means of fossil fuel	1.20
Reduce domestic and industrial demand	2.00

2.3.3 Governance options / institutional reform and awareness raising for climate adaptation in Egypt

Egypt has adopted the IWRM concept, including the need for demand management, as a basis for its National Water Resources Plan. However there is only there is only limited interaction between different ministries, authorities and state research institutes (Luzi 2010). Climate adaptation (and mitigation) and water management would benefit from better defined competencies and coordination between institutions, including interactions with science. For example activities related to irrigation, drainage flow and downstream reuse need to be jointly managed by the water and agricultural ministries. If the various donors play a critical role in some of the ministries (Jobbins 2012), a coordinated donor strategy on mainstreaming climate change adaptation into water management and related sectors, agreed upon with the local partners will be important.

Egypt's Inter-Ministerial Committee on Climate Change, which was set up to mainstream climate change into National Planning could facilitate cross-sectoral cooperation and hence deserves further support.

The National Research centres under the water and agricultural ministries can help to bridge the gap between science and implementation, e.g. through integration with international science on the one hand and extension services, water user associations, participatory irrigation management on the other hand. For example, the Nile Forecast Center relies on the PRECIS (Hadley Center) regional climate scenarios – and hence could benefit from using the new UN-ESCWA / SMHI regional ensemble climate scenarios[19]. According to the National Communications Egypt requires improved and applicable climate change information.

The wording in the 2nd National Communications may indicate an underestimation of the importance of institutional adaptation and awareness-raising relative to "hard" or infrastructure measures.

2.3.4 Integration of water and other sectors for climate adaptation and mitigation in Egypt

Egypt's cities expand rapidly, with Cairo having doubled in size in less than 20 years at the cost of scarce agricultural land – see figure below

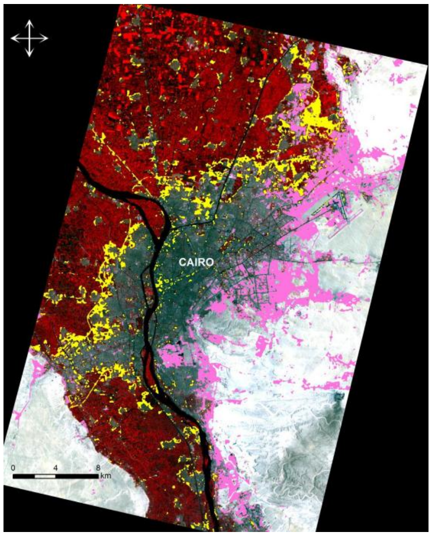

Figure 14

Expansion of Cairo, in yellow: loss of prime agricultural land over the last 20 years (Ghoneim E., EGM ESCWA meeting 6 July 2012, Beirut)

[19] www.escwa.un.org/RICCAR

Given that water and land both constrain agriculture and food security, land-, spatial- and urban planning need to be integrated with water (and climate adaptation) strategies for optimal landscape configuration.

Currently about 13% of power production is hydropower, mostly from the Aswan High Dam. Beyond that, Egypt has ambitious energy goals, such as 20 % renewable energy by 2020 and an increase in energy efficiency by 20% in 2022. Increases in energy (and other resource use) efficiencies are also positive from a climate adaptation perspective, but not sufficient to significantly reduce resource use and greenhouse gas emissions in view of the fact that Egypt's population is growing by 20% every 13 years.

The potential for using renewable energy (e.g. solar) for water pumping is higher than in Jordan, given the less pronounced topography, which does not require water to be pumped across elevation gradients of 1000 meters and more, like in the case of Amman's drinking water supply.

Energy recovery from wastewater treatment also holds significant potential and is already being implemented – see e.g. Al Gabal Asfar plant.

Another important link between climate adaptation and mitigation relates to livestock production, which under current management is not only very water and energy intensive, but also responsible for major greenhouse gas emissions. If current livestock production patterns can be complemented with aquaculture (using drainage effluent or brackish water), income and protein source diversification could be achieved. As explained before, such diversification may increase the resilience of production systems. If climate and water pressures increase further so that incremental adaptation fails, a shift to aquaculture may also become an opportunity for so-called "transformative change", i.e. a shift to completely different production systems.

2.3.5 Current water and climate plans and strategies in Egypt

The **National Water Resources Plan** is done in 20 year intervals, the current one (which was updated in 2005) runs until 2017. The next plan, which will cover the period from 2017 until 2037, will be prepared soon. There will also be a vision until 2050. The national plan contains a long list of desirable measures and accordingly the document recognizes that "it is a real challenge to implement this strategy". For example the document requests an "increase in treatment of municipal sewage and wastewater", which is urgently required, given the lack of additional water resources and at the same time degradation of water quality from untreated wastewater throughout the system.

The National Water Resources Plan also acknowledges that co-operation between Nile basin countries is "promising but not sufficiently developed". So the open question is, how to lift this important insight (also from a climate perspective) from the water sector to the required political level for action.

For "integrating water policies and activities on the national and local level", the current Plan proposes "establishing a National Water Council and…Regional Management Committees". Such councils and committees – if established with sufficient implementing capacity – can also support mainstreaming of climate change adaptation into water management.

"Participatory approaches" and "institutional structure with strong water boards and water user associations" as proposed in the Plan are important in order to address root causes of local vulnerability and develop context specific adaptation options. The proposal for "water allocations and distribution systems based on equity" would be a step in the right direction towards integrating climate change adaptation with development goals. The Plan further recognizes that "water management is not an aim in itself, but it should support the achievement of other….social, economic and environmental goals" – among which reduced vulnerability and adaptation to climate change have high priority.

However, on climate change itself the Plan remains relatively quiet: "…it can be concluded that these [climate change] impacts are small considering Egypt as a whole and can be dealt with in time" and that "flooding is not going to be a major issue". While it is true that Egypt is well endowed with storage capacity – the volume of Lake Nasser is about twice the average annual flow of the Nile – many other technical, socio-economic and institutional measures are not yet linked to climate change.

The 1st **National Communications** to the UNFCCC were published in 1999, the 2nd National Communications in 2010, and the 3rd National Communications are now in their second phase, to be published in 2014. So now is the time to integrate new adaptation issues and innovations. The National Communications list a number of climate change scenarios and resulting impacts in terms of changing Nile flows – with a wide range of future projections, which (different from the projections for the MENA region itself) don't even agree on the direction of change of runoff in the Nile headwaters. See also comparison of different model outputs for the Nile basin by Conway and Schippers below.

The 2nd National Communications focus on technical adaptation options. They claim that "the most significant constraint to effective environmental policy making and implementation in Egypt is the lack of reliable and timely information". So the development of an integrated data and information system in the water sector, along the lines of what is being developed at the Jordanian Ministry of Water and Irrigation, could also support climate change adaptation.

Another constraint to be addressed is - according to some stakeholders – an inefficiency and lack of coordination in policy and decision making and in particular the lack of enforcement of existing legislation. Examples for the lack of enforcement are the caveats in protecting water quality from the effects of wastewater pollution.

The 2nd National Communications themselves confirm the need for new approaches to solve the mounting problems – in particular the fact the all available water resources are fully exploited or even overexploited, while demand keeps rising fast.

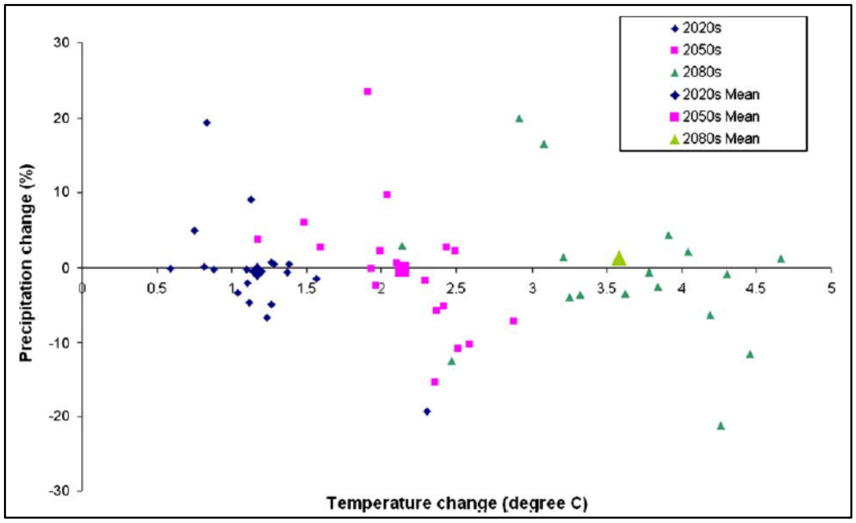

Figure 16

Nile basin precipitation and temperature projection of different climate models (Conway and Schippers 2011)

A national **Adaptation Strategy to Climate Change** is currently being developed under the Cabinet of Ministers, which requires further concretization and more expert inputs. The draft of this adaptation strategy (referring here to the version from December 2011) is very brief on adaptation options in the water sector (less than 2 pages out of 160 pages total) hence it would benefit from closer coordination with the National Water Resources Plan. Also, the similar challenges and approaches tested in other MENA countries could feed into Egypt's climate adaptation strategy.

The strategy mentions the need for integrated water and land management, which is an important entry point for adaptation. It further assumes a decrease in plant productivity under climate change. This assumption however does not take into account so called CO_2 fertilization effects (improved water use efficiency under higher atmospheric CO_2 concentration). The strategy emphasizes the role of water user associations and agricultural extension services for locally adapted and participatory approaches to climate change adaptation, hence a downscaling of climate impact assessments and adaptation strategies to specific local contexts is important. The strategy further suggests different operational rules for the Aswan High Dam in response to future uncertainty and potentially increased annual Nile flow. Here again the latest regional climate scenarios from the UN-ESCWA / SMHI initiative[20] can provide important input.

A **National Strategy for Sustainable Agricultural Development** up until 2030 is under development, which provides another good opportunity for mainstreaming of climate change adaptation into agricultural water management and to strengthen links between water and land management.

In addition to these plans and strategies, researchers like Medany et al. (2007) have provided some targeted recommendations for Egypt related to climate change adaptation:

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[20] www.escwa.un.org/RICCAR

- adaptation strategies should consider the simple and low cost adaptation measures - which may include those informed by traditional knowledge to meet local conditions;
- prioritization of improved scientific capacity for development planning;
- making existing bottom-up approaches of planning and implementing adaptation and mitigation strategies in Egypt more efficient;
- involving stakeholders to develop community-based measures and improve the adaptive capacity of different human sectors and actors;
- increasing public awareness;
- improving communities' adaptive capacity based on scientific evidence.

Some stakeholders had mentioned an Egyptian "Renewable Energy Strategy", which – if available – could provide additional entry points for integration of climate change adaptation and mitigation.

2.3.6 Institutions consulted and potentially relevant additional institutions in Egypt

- Ministry of Water Resources & Irrigation
- Ministry of Agriculture
- Ministry of Environment
- Egyptian Environmental Affairs Agency (EEAA, under the Cabinet of Ministers)
- Environment and Climate Research Institute (ECRI), which among other issues, studies the effects of climate variability on water resources
- International Water Management Institute, Cairo

Additional potentially relevant institutions:

- National Water Research Center / Institutes
- Center for Land Use Management under the Cabinet of Ministers
- Authority of Renewable Energy (under the Ministry of Energy and Electricity)
- Climate Change Information Centre under the Agricultural Research Center
- National (inter-ministerial) Committee for Climate Change, responsible for developing a national climate change policy, currently headed by the chief executive officer of EEAA
- Arab Office for Youth and Environment, which raises awareness on climate change (environmental NGO since 1979)
- Centre for Environment and Development for the Arab Region and Europe (CEDARE)

2.3.7 Pilot project in Egypt

The proposed pilot project, on improved management of drainage water quality for reuse, would address an urgent need in climate change adaptation, given the strong reliance of downstream users on drainage water (and waste water) from upstream. Water quality improvements are one of the few remaining supply-side options for Egypt, in response to climate and other pressures.

Another opportunity for climate adaptation pilot projects would be on **climate-resilient cities** addressing issues such as integrated urban planning, wastewater treatment, urban agriculture, urban green space, more efficient heating and cooling, including risks specifically related to climate change such as urban flooding and sewer overflows and urban heat islands. Population growth of cities (also smaller cities) is much higher than national averages, due to high fertility rates, concentration of economic activity and migration etc. Urbanisation currently stands at 43% of total population in Egypt, 78% in Jordan and 87% in Lebanon (World Bank Indicators). Generally, migration patterns are such that the urban poor move towards the city centre and the rich towards suburban (gated) communities, while the rural poor are attracted towards peri-urban areas. Urban poor in informal settlements are particularly vulnerable, often deprived of basic services (water, sanitation, energy).

2.3.8 Recommendations for Egypt

As indicated in Egypt's 2nd National Communications, there is an urgent need for new solutions given the quickly growing water demand while available conventional resources are already fully exploited. Climate models indicate that the main pressure on the water sector in Egypt will not be from reduced rainfall (as projected for the rest of the MENA region), but from higher evapotranspiration with increasing temperatures. Additionally coastal aquifers will be threatened by sea level rise.

This situation and Egypt's downstream position in the Nile makes trans-boundary collaboration a high priority in adaptation to climate change and water scarcity. Such collaboration would have significant overall benefits in terms of over Nile basin water productivity. Improved landscape configuration (e.g. selecting sites for water storage, hydropower production, crop production and livestock rearing as to minimize evaporative losses) and sharing of water-smart knowledge and technologies by Egypt with the other Nile riparians have large potential to "increase the pie".

Within Egypt, adaptation opportunities on the supply side are mainly limited to improvements in water quality. Given Egypt's situation and in particular that of the Nile basin population at the downstream end of the Nile, water reuse depends on avoiding further degradation of water quality which would translate into losses in water availability.

Like in the other pilot countries, highest priority for climate change adaptation has to be on demand side management. While agricultural water productivity is already relatively high in Egypt, there are nevertheless large opportunities for further improvement through technological, economic and institutional measures.

Virtual water imports remain and important measure which needs to be integrated in overall water and land management and hence also climate adaptation strategies. Its costs and benefits need to be transparently and comprehensively compared to other water management options.

The lack of coordination among institutions (e.g. between the National Adaptation Strategy to Climate Change and the National Water Resources Plan) and the lack of enforcement of existing regulations (e.g. in wastewater treatment) indicate that technical solutions alone will not be sufficient to adapt to increasing water scarcity and climate change.

There are a number of opportunities for mainstreaming climate change adaptation into water management through revisions or new development of

- the National Water Resources Plan
- the National Communications to UNFCCC
- the National Adaptation Strategy to Climate Change
- the National Strategy for Sustainable Agricultural Development

Egypt's National Research Centres can play a key role in bridging between science, policy making and dissemination and application of new knowledge and scientific evidence. These centres may also take on responsibility for the required integrated water data and information system.

3 Draft Guidelines for a Regional Climate Adaptation Strategy

It is certainly quite ambitious to derive from the short consultations with selected stakeholders from the three pilot countries general guidelines for mainstreaming climate change adaptation in the water sector in the MENA region. However, here are a few initial suggestions for issues and steps to include, which – like all other sections of this report – need to be developed further, jointly with local partners:

Objectives

- Integration of climate adaptation (and mitigation) with sectoral policies, strategies and plans, in particular water, taking into account related sectors such as agriculture, land/spatial planning, environment and energy, emphasizing inter-linkages and defining current and future challenges; the objective should therefore be to mainstream adaptation practices that yield co-benefits by identifying synergies with other sectors;
- This means mainstreaming climate change into water plans, in close coordination with agricultural, environmental and energy strategies;
- Mainstreaming thus requires inter-ministerial and inter-agency collaboration which in turn needs support from the highest levels; meaning also both horizontal and vertical coordination[21].

Starting points

[21] This is widely recognized, but few countries have managed to define a clear set of responsibilities for each level of governance or set up coordinating bodies to manage this. Multi-level governance is essential to effective adaptation; action is required at the national, regional and local levels.

- Adaptation should start from current climate vulnerabilities and risks in the context of other risks, and from there move on to address new, changing and emerging risks;
- Realize that most climate change adaptation measures are also good IWRM options and hence not necessarily completely new;
- Interest in and funding for climate change adaptation can be used to implement much needed IWRM measures and strategies, and to improve and reform water governance;
- Likewise, best-practice IWRM and win-win measures can be starting points for climate change adaptation, especially if stakeholders are sceptical or perceive climate change as 'too uncertain to act upon';
- The starting points will be somewhat different for each country, given their respective situation; some more wealthy countries will have higher technological and institutional capacity e.g. in their water ministries and authorities, whilst others will struggle to take on board and adjust to the additional challenges of mainstreaming adaptation and additional complexities associated with the inter-linkages.

Enabling adaptation mainstreaming

- Provide enabling conditions for technological innovations and their dissemination and uptake across the region;
- develop proposals for measures and strategies for the water and related sectors, that will allow to tap new international climate adaptation (and mitigation) funds;
- consider the use of economic instruments such as taxes or tax breaks to incentivize improved water and energy efficiency (with indirect benefits on other resources) whilst generating a domestic source of revenue to invest in mainstreaming adaptation;
- encourage in particular private investment in new climate smart water and energy technologies;
- use emerging national coordinating mechanisms, such as inter-ministerial committees or cross-cutting programs on climate policies / climate adaptation planning in order to integrate management and governance across water, land, environment and energy sectors;

Partnerships

- Adaptation is a process of learning; it is essential to involve a range of national and local stakeholders and decision makers in that learning process, in order to benefit from their unique insights and to share the lessons learned;
- enable and support adaptive management and learning organizations, sufficiently flexible to continuously incorporate new knowledge in water management and governance (e.g. supported by WEAP as a participatory planning tool);
- establish a regional community of practice; take a regional approach to knowledge sharing and capacity building, and identify opportunities for regional and trans-boundary cooperation, fund raising and funding of climate change adaptation;

- share adaptation experience / best practices / new technologies / innovations between MENA countries, first between countries with similar context, e.g. Jordan, Lebanon, and Syria for Mashreq region and Morocco, Tunisia, Algeria and Libya for Maghreb region, or also between regions with similar topography (e.g. mountain regions of Lebanon, Tunisia and Libya) or similar in hydro-meteorological or agro-ecological or socio-economic conditions – this requires region-wide mapping of adaptation contexts as a basis for outscaling and upscaling;

Links across scales

- seek synergies between national water strategies and the Arab Strategy for Water Security[22] and its associated Action Plan (to be developed very soon), coordinated by ACSAD under the auspices of the Arab Ministerial Water Council
- build regional climate change expertise, databases and tools, e.g. in a centres of excellence – ACSAD climate working group and possibly other groups;
- disseminate and provide training for utilization of UN ESCWA / SMHI ensemble regional climate scenarios and vulnerability assessment.

Methods / approaches

- explicitly recognize uncertainty as a key element of adaptation; mainstream adaptation by developing water strategies that aim to achieve learning and/ or resilience ("robust adaptation measures");
- diversify water supply and demand management options for increasing resilience;
- identify limitations of current IWRM practices – in particular critical climate-related and other thresholds beyond which conventional practices and incremental adaptation will fail – and jointly with stakeholders select modified or new practices for climate-proofing IWRM;
- develop a baseline vulnerability assessment against which future reductions in vulnerability and adaptation strategies can be measured.

The **GIZ climate proofing guideline tool** was discussed and initially tested on selected adaptation options, during the GIZ / ACSAD workshop in Beirut on 7 July. The tool was considered useful for systematically assessing, comparing and prioritizing different adaptation options, possibly by way of adaptation matrixes (rows: individual options, columns: criteria against which to test).
The individual steps described in the tool may need some adaptation to the MENA region – here is an initial proposal for a sequence of steps according to the discussions in Beirut:

- which current water management measures address climate change impacts and how?

[22] The Arab Strategy for Water Security addresses issues such as: reducing relative disparity between Arab states, maximum possible self-sufficiency, expanding desalination, use of alternative clean energy source in desalination, economic alternatives for water use, holistic approaches, inability of national institutions, low levels of scientific research

- which effect(s) of climate change is (are) addressed - e.g. change in precipitation, temperature, droughts, other?
- how does the time horizon of these measures (e.g. single growing seasons for crop choices vs. several decades for water infrastructure) compare to the projected time horizon of climate change impacts? note that some impacts e.g. salinization of groundwater are almost irreversible at human time scales
- how do these measures reduce vulnerability?
- will the adaptation measures themselves be vulnerable to climate change, and if so how are they vulnerable ("exposure units"), is some part of the infrastructure vulnerable or is it a resource input or the staff on which the implementation depends or…?
- are there limits to the usefulness of the measures under climate change, i.e. are there critical thresholds of climate change beyond which these options fail (e.g. groundwater based irrigation failing if groundwater recharge stops)?
- how can current measures be made more robust?
- what are benefits and costs / side effects (e.g. environmental effects) of each of the adaptation measures, also in terms of climate mitigation (e.g. increasing energy demand and greenhouse gas emission of desalination or co-benefits of energy and water savings)?
- how should the different adaptation measures be prioritized?
- what would adaptive management look like, i.e. how can adaptation measures and strategies remain flexibility to adjust to changing pressures and new knowledge?
- which institutions and individuals are responsible for the particular measure, do they need capacity building for mainstreaming climate change adaptation, should others be involved?

4 Recommendations

To start with, there was a clear request from various partners: "no more papers, but action". While this is understandable and the identification of concrete adaptation measures and opportunities for mainstreaming climate change adaptation into current practices is very important indeed, one must also realize that current strategies and plans are seriously deficient in many respects. As explained for each of the three countries, climate change and adaptation currently plays a minor or no role in water sector planning, strategies and action plans. Even in cases where climate change is explicitly mentioned, action is largely lacking. This situation reflects a general underestimation of climate change impacts on water availability, demand and management (relative to other pressures) and over-emphasis on remaining uncertainties in climate scenarios, which delays action and shifts costs to future generations. Neglecting climate change will likely lead to 'lock-in' situations and path dependencies (e.g. when investments in long-term water infrastructure are not climate-proof), increasing vulnerability (so called 'mal-adaptation') and re-active emergency type responses to crises rather than pro-active adaptation.

Efforts to mainstream climate adaptation into water planning can build on lessons learned from the efforts of other MENA (and non-MENA) countries that already have experience with adaptation processes. Individual MENA countries have initiated climate adaptation activities that should be synthesized and experience shared within the region. Also the widespread use of WEAP for water and climate adaptation planning in various MENA countries[23] provides a solid base for a regional adaptation initiative. Such a consolidated region adaptation knowledge base can also provide the required underpinning for outscaling and upscaling of the ACCWaM adaptation pilot projects (which may be funded through the new global adaptation funding mechanisms).

Accordingly there is significant potential – and need – to mainstream climate change adaptation into existing strategies and plans. Any opportunity to do so should be taken advantage of, e.g. when these documents are updated or revised. Given the nature of climate change with long-term and lasting effects, pro-active approaches are required at all levels, local, national and regional. Waiting for the full effects of climate change to manifests themselves before taking action will come at high cost.

A wide range of technical adaptation measures, as developed under IWRM, are available and have been successfully tested and implemented in different MENA countries. Knowledge platforms such as weADAPT[24] can be used to share and disseminate adaptation technologies, knowledge and experience across the MENA region.

As discussed for the pilot countries, demand management has the largest potential for adapting to climate change and water scarcity. First priority must be reductions in agricultural water demands through technological, economic and institutional measures, given that agriculture is still the largest water user in the MENA region. But also municipal demand saving has huge potential, in terms of loss reduction but also lowering of household demands through water smart appliances and behaviour.

[23] www.weap21.org

[24] weadapt.org

On the supply side, the largest adaptation potentials, for bridging the water gap and reducing uncertainty (depending on specific context) are with i) wastewater and grey water reuse, ii) water quality protection, iii) water harvesting and storage, and iv) possibly also desalination, if that can be powered by renewable energy - see Aqaba Solar Water Project (MedCSD 2009) and most recent announcements for large scale solar desalination by Qatar and other Gulf states, see also World Bank 2012. Given its still higher costs than most other supply and demand management measures (see table by Immerzeel et al in section 2.3.2) it would require support, e.g. by the Gulf countries to further develop the technology, bring costs down and deal with environmental externalities. This could be an opportunity for implementing the goal of the Arab Strategy for Water Security (LAS 2012) to reduce inequity among Arab countries.

Various discussions with local stakeholders addressed the question if large **centralized vs. decentralized** smaller distributed solutions are more appropriate for addressing climate risks and adaptation and for improving water and other resource use efficiencies. Are decentralized wastewater treatment, solar driven small water pumping units, storage via small ponds and hill lakes more likely to increase resilience against climate and other risks than larger solutions, such as long distance water transfers and other mega-projects? While the answer to that question depends on the national and local context, the general principle applies also in the MENA region, that **diversification increases resilience**. Also local participation is generally facilitated by smaller scale distributed solutions (while private sector involvement seems to focus on larger solutions). Reducing local vulnerability requires participatory processes for identifying appropriate adaptation measures which contextualize, complement, and implement national and top-down policies, strategies and plans. Across the MENA region, water user associations are foreseen to provide this local perspective, but are generally not operational yet. However decentralized individual solutions – which may not have been planned but simply an outcome of weak regulation and management - are not sustainable per se. For example about 20% of the total electricity generation in Lebanon is from small private back-up generators – a response to unreliable central supply – which is the most expensive form of power generation economically and in terms of air pollution and noise (Farajalla et al 2011).

Synergies from **integrated approaches**, e.g. across water and land management, between water and energy management, and between adaptation and mitigation need to be explored jointly with local partners. Depending on climate and agro-ecological conditions, improved land management can unlock the potential of large amounts of green water and increase overall water productivity drastically. In particular spatial and urban planning is still completely disconnected from water management, a fact that will further aggravate climate driven water problems. The high import bill for energy (Lebanon and Jordan each import more than 95 % of their primary energy needs) in combination with significant potential for energy savings in the water sector in the MENA region (Saudi Arabia, alone uses about 1.5 million barrels of oil per day for desalination World Bank 2011) – the enormous water demands in some parts of the water sector call for better coordination of these sectors and between adaptation and mitigation. Without water smart energy supply and energy smart water supply, demands in Southern and Eastern Mediterranean countries are projected to grow rapidly, from 150 km^3 water per year in 2005 to 200 km^3 in 2025, and from 20 TWh of electricity per year in 2005 to 200 TWh in 2025 (Plan Bleu). Successful experiences should be shared across sectors, e.g. energy contracting (sharing revenues from energy saving with the contractor) might also work for "water contracting". In any case, more realistic water pricing will play an important role in demand management.

Economic incentives and market mechanism that reflect the true value of water and costs for water provisioning, are key for **demand management**, reduction of wastage and improvements in resource productivity, and hence are an important pre-requisite for adapting to growing climate and other pressures. However in particular in agriculture, the biggest water user in the region, perverse subsidies for water and energy (e.g. electricity for water pumping) persist in many MENA countries, largely due to vested interests in water policy making.

Net import of **virtual water** on which the MENA region has increasingly become dependent (Allan 2001, Wingqvist et al 2010), arguably is the most important adaptation measure and contribution to food security in the MENA region – see figure 17 below. Hence it needs to be fully integrated with water management, and its costs and benefits (including exposure to world commodity market volatilities and associated vulnerability of importing countries) need to be transparently compared with those of other water supply and demand management measures.

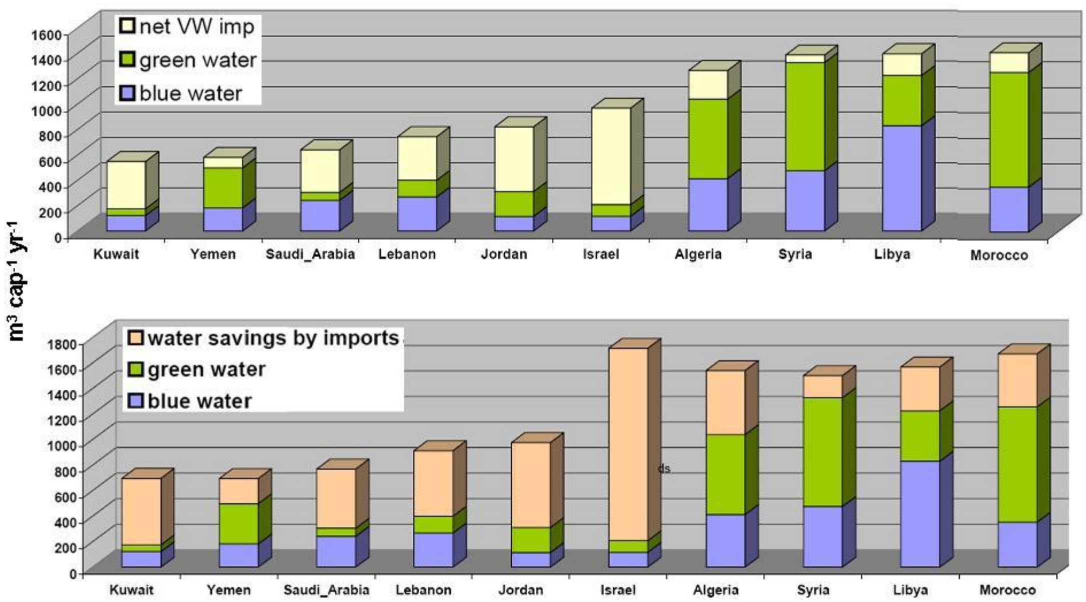

Figure 17
Relative contributions of blue, green and virtual water to food security in MENA countries, upper figure based on water use in the exporting countries, lower figure based on the water saved by not producing in the importing countries, blue water is irrigation water, green water is direct contribution from rainfall (Hoff 2013)

While technological innovation and economic incentives can help to mitigate current water scarcity and delay the crossing of critical water scarcity thresholds, discussions with stakeholders identified as most important the need for **improved water governance**, in particular the enforcement of existing laws and regulations.
According to Rogers et al (2003) the following are key elements of improved governance:

- inclusiveness
- accountability
- participation
- transparency
- predictability
- responsiveness

Unfortunately, the full implementation of these principles and hence of genuine water reforms that would also better prepare for future climate conditions are still pending. As stated by Al Jayyousi (2012), water sector reforms would also need to address the closely interlinked issues of water, food and energy security – e.g. through national coordination mechanism, inter-ministerial committees, institutional capacity building and extension services, as well as regional communities of practice or learning alliances.

Currently integrated approaches are primarily addressed by the respective Ministries of Environment and/or environmental authorities, rather than more powerful and influential water and agricultural ministries (see also Zeitoun et al 2012). Hence, collaboration of these separate sectors and ministries is essential for effective adaptation.

Integrated and participatory approaches further require closer links between governmental and non-governmental (and private) sectors, with NGOs now beginning to form regional alliances such as the Arab Climate Alliance (ACA 2012). Hence development cooperation should direct its efforts on climate mainstreaming also to local, national and regional NGOs.

While the focus of this report is on the water sector, measures in **other sectors** also impact or are impacted by water resources management, e.g. agriculture, forestry, land use, grazing-, rangeland- and environmental management, and energy. If management and governance are coordinated between sectors e.g. through multi-functional systems (such as conservation agriculture, aqua-cultures, water and energy co-generation etc.), synergies can be developed and overall resource productivity – and eventually resilience - are likely to be higher than under strictly sectoral management (Hoff 2011). Similarly, coordinated climate adaptation and mitigation activities can result in co-benefits, higher water and energy productivity and eventually lower costs. Accordingly, policies, strategies and action plans in other water-related sectors should be carefully screened for opportunities to mainstream climate change adaptation into water management (Bazilian et al 2011, UNEP 2011).

While the National Communications to the UNFCCC of the three pilot countries are generally cross-cutting - across disciplines and sectors – they are rather general and unspecific when it comes to concrete measures and target groups. The National Water Plans in contrast are more specific about required measures and actors, but they lack the coordination with other sectors. So the two separate types of planning processes and documents need to be better linked for successful mainstreaming of climate change adaptation into water management. In each of the three pilot countries there are excellent opportunities for doing so, through ongoing or upcoming revisions of key water and climate planning documents.

Lastly, this initial study for the three pilot countries Lebanon, Jordan and Egypt needs to be continued through iterative assessments of local challenges, for developing context-specific adaptation strategies and actions jointly with local partners. Upcoming events such as the Arab Water Week[25] or the Abu Dhabi Sustainability Week[26] as well as initiatives such as DesertTec[27] provide opportunities for integrating this pilot study with larger climate adaptation and mitigation activities in the MENA region.

[25] www.arabwaterweek.org

[26] www.abudhabisustainabilityweek.com

[27] www.desertec.org

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