Knowledge for SDG Action in West Asia and North Africa

R-KNOW Water Governance Best Practices within the Water, Energy, Food and Climate Change Nexus

INTERNATIONAL UNION FOR CONSERVATION OF NATURE - REGIONAL OFFICE FOR WEST ASIA

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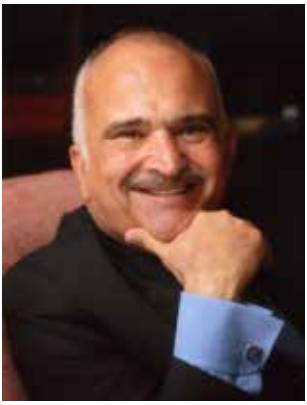
FOREWORD



The West Asia-North Africa region sits at the center of a global environmental crisis. The stakeholders of the region - citizens, civil society and policy makers alike - must work together to identify pathways to meet the goals of durable development. Time-bound, fragmented or state-centric interventions will not be sufficient. Solutions must be regional, both in conceptualization and implementation.

The region's challenges are well articulated and evidenced. It is no longer debatable that climate change is exacerbating the region's food, energy and water challenges. However, despite fragile and limited water resources, the agricultural sector constitutes the largest consumer of water. Moreover, efforts to promote economic growth, while at the same time preserving fragile ecosystems, continue to be frustrated by reliance on fossil fuels.

To overcome these challenges the region must strive towards integrated water resource management - a concept that is inseparable from the water-energy-food nexus approach. These pillars are *sine qua non* for policy coherence, innovation and equitable development. It is clear that humanity is the pivot of durable development and we should always construct it as a nexus between water, energy and human dignity. This nexus approach also serves as an opportunity for countries in the West Asia-North Africa region to become leaders in water-food security and renewable energy.

The imperative of realizing the Sustainable Development Goals in a timely and equitable manner requires catalytic change at multiple levels across inter-related sectors. It is with this goal in mind that this knowledge book on SDG action in the West Asia-North Africa region was developed. Lessons from different case studies illuminate pathways for the region to achieve water security, affordable and reliable energy, climate change resilience and restored ecosystems.

Ultimately, it is the people of the region who must forge a pathway towards robust growth, social equity and human security, but without compromising the environment. Civil society will certainly play a critical role in this process, and must be empowered to assist in developing natural resource management strategies in partnership with governments and the private sector.

Let us all realise that the prevailing resource scarcity is not only a challenge, but also an opportunity to bring about lasting peace and human dignity to the region.

HRH Prince El Hassan bin Talal
Chairman
The West Asia-North Africa (WANA) Institute

WANA
INSTITUTE

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PREFACE

The Regional Knowledge Network on Systemic Approaches to Sustainable Water Resources Management (R-KNOW) forms part of IUCN ROWA's Regional Programme on Water Resources and Climate Change and is implemented in close cooperation with a number of key partners in the MENA Water Sector, such as CEDARE in Egypt, PHG in Palestine, SPNL in Lebanon, AWO in Jordan, UAE in Morocco, and EMWIS in France. R-KNOW has been started as a project funded by the European Union (EU) (2013-2015) to assist in strengthening the application of systematic approaches to sustainable water resources management in five countries (Lebanon, Jordan, Palestine, Morocco and Egypt) and to share all relevant knowledge on these issues. Over time R-KNOW has slightly shifted focus to better emphasize the needs for local water governance and participatory approaches to water resource management, while embedding such approaches more recently within the broader arenas of Ecosystem-based Management and a Water, Energy, Food and Climate Change Adaptation Nexus. The partners in R-KNOW have the firm commitment to pursue their collaboration and notably through activities that contribute to a strong R-KNOW (http://www.rknow.net) that actively contributes to meeting Sustainable Development Goals as have been defined in 2015.

The core of this knowledge is the information collected on practical implementation of such systemic approaches in relevant pilot projects in different contexts. As lessons learnt were not sufficiently shared among those intending to apply systemic approaches, it was deemed necessary to make an inventory of and synthesise the information about the experiences already made for others to refer and learn from[1].

As part of R-KNOW's Knowledge Strategy for creating and sharing knowledge, knowledge products will be developed for its different Sustainable Water Resources Management (SWRM) Themes. This document is the first in a series of R-KNOW knowledge products, bringing together work done in the domain of sustainable water resources management through integrated and participatory development approaches.

This document will share with a broad audience of practitioners and policy makers, notably in the West Asia and Mediterranean regions, **what integrated approaches are necessary to make water resources management and climate change resilience actions a success.** It will describe the underlying conceptual framework of these different approaches that underpin successful actions in the four Thematic Areas distinguished within the R-KNOW:

(i) Local Water Governance,

(ii) Climate Change and Water,

(iii) Water, Food and Energy Nexus, and

(iv) Innovative & Sustainable Water Technologies.

This conceptual framework recognizes that in the region targeted by R-KNOW, development and management of water resources is closely inter-linked with the development and management of drylands and rangelands through appropriate ecosystem approaches. The publication will illustrate the different integrated approaches proposed by sharing hands-on experience in their implementation, presented as specific case studies prepared by the R-KNOW partners. From these case studies it will draw lessons and formulate recommendations that form part of the in-depth knowledge generation and sharing process engaging the R-KNOW partners and stakeholders in their respective five countries mentioned above.

[1] http://rknow.net/index.php/en/themes-en/project-database

R-KNOW partners:

This knowledge book was produced with the support and commitment of the R-KNOW partners and team. They are:

- Arab Women Organization of Jordan (AWO) - Jordan
- Palestinian Hydrology Group for Water and Environmental Resources Development (PHG) - Palestine
- Society for the Protection of Nature in Lebanon (SPNL) - Lebanon
- Centre for Environment and Development for the Arab Region and Europe (CEDARE) - Egypt
- University Abdelmalek Essaâdi of Tanger Tetouan - Morocco
- Technical Unit (Euro-Mediterranean Information System on the know-how in the Water sector) (EMWIS - SEMIDE) - France
- International Union for Conservation of Nature (IUCN), Global Water Programme - Switzerland and the Regional Office for West Asia (ROWA) - Jordan

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- Ms. Tala Moukaddem and Ms. Bassima Khatib from Society for the Protection of Nature in Lebanon (SPNL) in Lebanon.

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List of Acronyms

ATED	Talasemtane Association for the Environment and Development
AWO	Arab Women Organization of Jordan
CBD	The Convention of Biological Diversity
CBOs	Community Based Organizations
CDP	Communal Development Plan
CEDARE	The Centre for Environment and Development for the Arab Region and Europe
CEOSS	The Coptic Evangelical Organization for Social Services
DRR	Disaster Risk Reduction
DSS	Decision Support Systems
EQA	Environmental Quality Authority
EU	European Union
FMU	Fund Management Unit
GWC	Ground Water Contracts
HDI	Human Development Index
HWF	Highland Water Forum
IBA	Important Bird Area
IFPRI	The International Food Policy Research Institute
IIUCN-Med	The International Union for Conservation of Nature - Centre for Mediterranean Cooperation
IPCC	Intergovernmental Panel on Climate Change
IUCN ROWA	The International Union for Conservation of Nature - Regional Office for West Asia
IWRM	Integrated Water Resources Management
IWA	International Water Association
JCC	Jordan Cooperative Corporation
JVA	Jordan Valley Authority
MENA	Middle East and North Africa Region
MLG	Ministry of Local Government
MoA	Ministry of Agriculture
MWI	Ministry of Water and Irrigation of Jordan
NGOs	Non-governmental Organizations
NW	North West
PHG	The Palestinian Hydrology Group for Water and Environmental Resources Development
PMC	Participatory Management Cycle
PPP	Public–Private Partnership
PWA	Palestine Water Authority
REWARD	The IUCN Regional Water Resources and Dry-lands Programme
RIDA	Resources, Infrastructure, Demand and Access
R-KNOW	The Regional Knowledge Network on Systemic Approaches to Sustainable Water Resources Management
RLC	Resilience Learning Cycle

SAR	Soil Sodium Adsorption Ratio
SDCA	Stakeholder Dialogue and Concerted Action
SDG	Sustainable Development Goals
SEARCH	Social, Ecological and Agricultural Resilience in the Face of Climate Change
SES	Social Ecological System
SPNL	The Society for the Protection of Nature in Lebanon
SFP	The Sahara Forest Project
SMI	Solar Management Interface
SSGs	Site Support Groups
SWP	Solar Water Pumping
SWRM	Sustainable Water Resources Management
UAE	The Abdelmalek Essaâdi University of Tetouan
UAWC	The Union of Agricultural Work Committees
UNDP	United Nations for Development Programme
WANI	The IUCN Water and Nature Initiative
WEF	The Water, Energy and Food security
WUA	Water Users Association
WUC	Water User Committees
RLC	Resilience Learning Cycle
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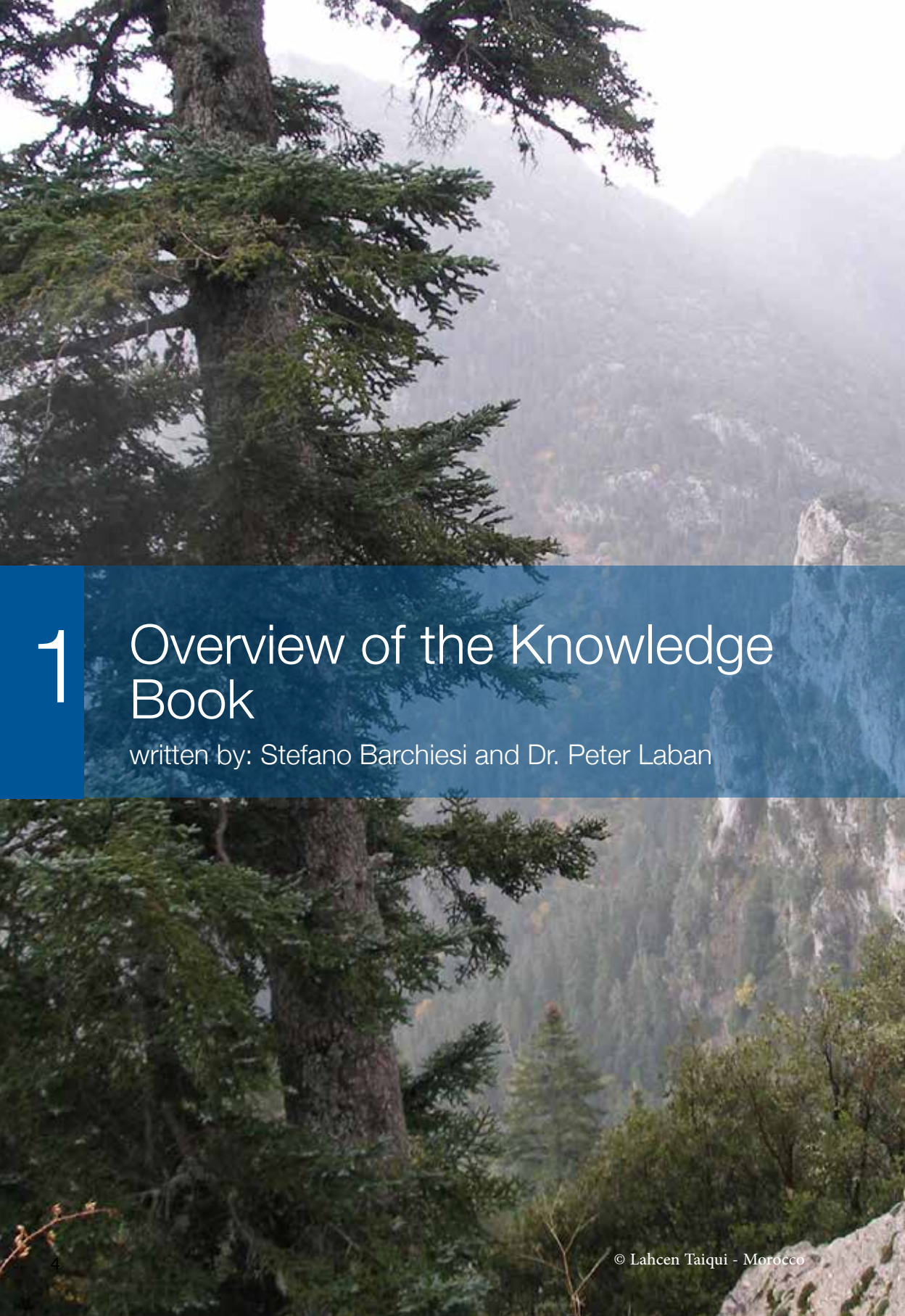

1 Overview of the Knowledge Book

written by: Stefano Barchiesi and Dr. Peter Laban

1. Overview of the Knowledge Book

Ecosystems and Hydrological Flows

Ecosystems, the services they provide and their response to human interferences are complex and often unpredictable. Sustainable management of water resources is directly connected to the ecosystems of which water resources form an integral part. According to the Convention on Biological Diversity (CBD) an **ecosystem** can be defined as *"a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit"*[2]. A more challenging definition, among many others, is *"a geographically specified system of organisms (including humans), the environment and the processes that control its dynamics"*[3] . This publication inserts itself in the broader community of Ecosystem-based Approaches when discussing sustainable water resources management avenues. There are many often slightly different definitions of what an **ecosystem approach** encompasses. The CBD defines it as *"a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in a sustainable way"*[4]. The US NOAA formulates it dynamically as follows: *"an ecosystem approach to management is geographically specified, adaptive, takes account of ecosystem knowledge and uncertainties, considers multiple external influences, and strives to balance diverse societal objectives. Implementation will need to be incremental and collaborative"*[5].

This paper will emphasize an ecosystem approach to Integrated Water Resources Management (IWRM). Water and hydrological flows are often highly determining the well-functioning of ecosystems and vice versa. Sustainably managed ecosystems can deliver important benefits through ecosystem services— such as water cycling or climate regulation— which have knock on effects on populations locally and externally. Improved ecosystem hydrological cycles lead to improved infiltration of water and reduced surface flow, which contribute to fewer floods and lower risk of drought (Davies et al., 2015). Indeed each action that takes place in an ecosystem has an impact on surface and groundwater (Barchiesi et al., 2014), while well-functioning hydrological flows guarantee that other ecosystem services can be provided as a function of the health of a rangeland ecosystem. Such ecosystem services can include higher biodiversity, soil fertility, carbon sequestration, quality of drinking water and its health benefits, and maintenance of rangeland products like fodder that are the basis of the pastoral economy (Davies et al., 2015) as is schematically illustrated in the diagram below.

[2] Convention on Biological Diversity; Article 2. https://www.cbd.int/ecosystem

[3] National Oceanic and Atmospheric Administration, US Department of Commerce; https://www.noaa.gov/com/files/0604corpboardecosystem.pdf

[4] Convention on Biological Diversity; https://www.cbd.int/ecosystem

[5] National Oceanic and Atmospheric Administration, US Department of Commerce; https://www.noaa.gov/com/files/0604corpboardecosystem.pdf

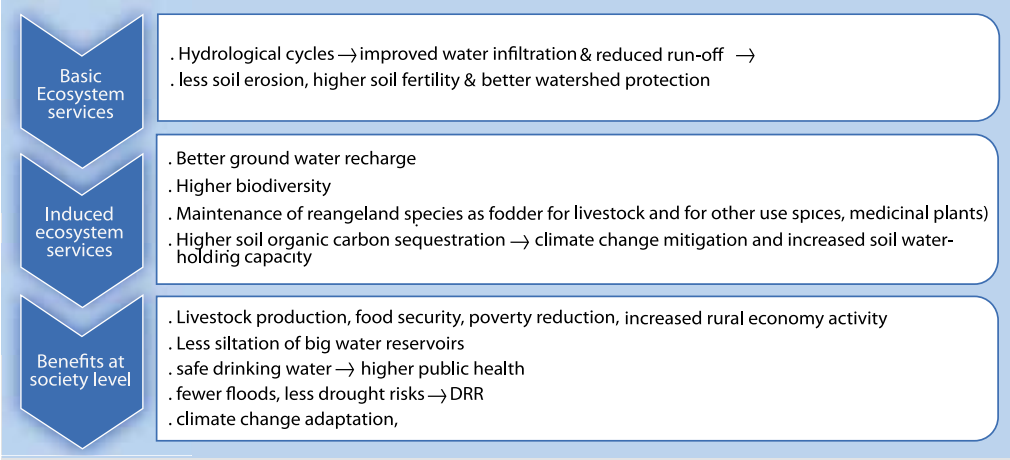

Figure 1. The "Value Chain" of Ecosystem Service Benefits of Healthy Hydrological Flows in the Dry Rangelands (Laban, 2015)

Ecosystems and IWRM

In the water sector much work is done under the umbrella of IWRM, as a system framework for improving understanding of the interdependencies of people, ecosystems and hydrology (Merrey, 2008). The Global Water Partnership (GWP, 2008) defines IWRM as *"a **systematic process** for the sustainable development, allocation and monitoring of water resource use in the context of social, economic and environmental objectives"*. IWRM is therefore based on the understanding that all the different uses of finite water resources are interdependent. A later definition calls IWRM a *"process which promotes the coordinated development and management of water, land and related resources in order to maximise the resultant economic and social welfare in an equitable manner, without compromising the sustainability of vital ecosystems"* (GWP, 2014).

Critics of IWRM today do not, in general, argue against the need for water management that integrates across sectors and scales. Their perception is that IWRM prioritises principles and process over practical action and pragmatic problem solving (Shah & van Koppen, 2006; Merrey, 2008; Giordano & Shah, 2014). Reconciling process and pragmatism is hence key to a future agenda for IWRM that will build on what has been achieved to date but has more impact. Fortunately, this is also key to making change in complex environments more manageable (Smith & Clausen, 2015).

The Global Water Partnership considers IWRM indeed as a framing concept that helps the water resources user and manager select a suitable mix and sequence of processes or steps that work in a given situation, context and country. They have been further elaborated into policies, legal frameworks, investment and financing structures, institutional roles and management instruments such as water resources assessments and plans at community and larger levels, stakeholder interaction and conflict resolution, as well as for information exchange tools.[6] Field experience in the IUCN Water and Nature Initiative (WANI) has shown that participatory ecosystem-based approaches to IWRM complement IWRM planning by giving more priority to direct implementation with the involvement of local ecosystem and water users, by using 'learning-by-doing' approaches to support innovation and suggest water policy reforms that integrate the needs of both people and nature (Smith & Cartin, 2011).

[6] http://www.gwp.org/en/ToolBox/TOOLS/

Ecosystems and Social Organization Systems

Indeed, when following a **systems** approach the management of nature and human society have to be integrated[7].

This would imply the use of Social Ecological System (SES) approaches where social and ecological systems are linked through feedback mechanisms, and that both display resilience and complexity, even whilst resilience has somewhat different meaning in social and ecological contexts[8]. A SES consists of a bio-geo-physical unit (e.g. a watershed) and its associated social actors and institutions. Social-ecological systems are complex and adaptive and delimited by spatial or functional boundaries surrounding particular ecosystems and their socio-institutional context (IUCN, 2014).

With regard to the social context it might be interesting to be inspired by system thinking *as applied in organizational management: management thinking that emphasizes the interdepend -ence and interactive nature of elements within and external to an organization[9] (sic: society)*. In this paper ample space will be given to the human components of ecosystem management in the sense of social organization and participatory stakeholder-led management of resources, also as in relation to adaptive capacity[10] of local communities and ecosystems.

Within the social organization dimension of ecosystem management, also the application of key adaptive management elements needs to be **systematic or systemic**: stakeholder concertation, public participation, an experimental and 'learning-by-doing' approach to resource management, and subsidiarity at watershed scale. Such systemic adaptive water management approaches need, moreover, to pay attention to the complexities associated with participation and collaboration in a polycentric governance system[11], the difficulty of experimenting in a real-world setting, the politicized nature of these discussions on governance, and uncertainty of the future (Huitema et al., 2009). In common practice, such adaptive management often translates into guidance for (i) developing practical methodologies for planning and decision-making and (ii) building on simple Decision Support Systems (DSS) (iii) influencing policies through knowledge networks and (iv) involving local communities and relevant stakeholders.

Developing systemic approaches to planning and management of water resources in dryland areas on a watershed/river basin basis was the goal of REWARD.[12] This programme was built on the experience of EMPOWERS[13] gained in the region with two systemic approaches, namely Stakeholder Dialogue and Concerted Action (SDCA) and the Participatory Management Cycle (PMC). They are systemic in that they involve semi-quantitative and interrelated tools to develop a more structured and detailed analysis of the eco-social system including the stakeholders, their roles and interests and their relation to the system being analysed. The PMC was later

[7] http://echo2.epfl.ch/VICAIRE/mod_2/chapt_10/main.htm

[8] In general, resilience can be defined as the *ability of a social and ecological system to absorb disturbances while maintaining the same basic structure and functioning and as the capacity for self–organization and the capacity to adapt to stress and change (Bates et al., 2008).*

[9] www.businessdictionary.com/defintion/systems-approach.html

[10] Adaptive capacity, of both the social and natural systems involved, can be defined as the ability of a system to adjust to climate change, to moderate potential damage, to take advantage of opportunities, or to cope with consequences. Adaptive capacity also relates to the ability of addressing vulnerability (sensitivity, exposure and capacity to respond), and enhancing resilience.(IUCN, 2014).

[11] Polycentric governance systems are defined as systems in which a different division of authority and a more complicated set of hierarchical relationships and "political spaces" have taken the place of mutually exclusive jurisdictions operating at the same level and the rational hierarchical ordering of jurisdictions at different spatial levels (Huitema et al., 2009).

[12] http://www.iucn.org/content/new-implementation-phase-reward-programme

[13] http://www.emwis.org/initiatives/medaeau/fol719001/fol199548

adopted by SEARCH[14] for use in a climate change resilience building context as a Resilience Learning Cycle (RLC) (IUCN, 2014). At the end of this introduction some more insights will be given to such SDCA and RLC approaches that are underpinning the work done in the R-KNOW partnerships as illustrated in the case studies that form the subject of this paper.

Four Thematic Entry Points to Sustainable Water Resources Management

In the context of the R-KNOW, four themes were identified based on priorities and expertise by project partners to build knowledge nodes around specific thematic areas within water resources management disciplines and practice.

The four thematic areas that have been selected by R-KNOW respond to urgent calls for more focus to be given to them by water organizations and the donor community. They relate to governance, climate change, the need to find synergies between action for food security, energy and water, as well as the urgent need to innovate and scale up technology. Although they are dealt with separately there is important interaction and overlap. Dealing with impact of climate change on water resources cannot be done without due attention to water governance, without integrating action for food security and energy while this further underscores that efforts have to be made to innovate and develop more performing and appropriate technologies.

1. Local Water Governance

Water is one of the most serious challenges facing sustainability on the planet. The water crisis is the result of failures in water governance which ultimately leads to failure in economic and social development, political instability and ecosystem integrity. Water management has long been considered a scientific process, based on objective knowledge of water systems, generic norms and rules, and technical solutions that are relatively independent of the political and institutional context. It reflected the world of the all-knowing expert who has an overview of the general interest, and who endeavours to know and steer as much as possible from a hierarchical decision-making position at a central government level.

Water governance relates to the range of political, social, economic and environmental systems that control decision-making and are put in place to develop and manage water resources and the delivery of water services at different levels of society without endangering the well-functioning of ecosystems. Water governance is much more about the way in which decisions are made (i.e. how, by whom, and under what conditions decisions are made) than the decisions themselves. As a result, it is often expressed in terms of transparency, accountability and information sharing. This is especially true for water governance at the local level.

Most water reform processes have focused on IWRM. However, IWRM implementation is a complex undertaking that presents major challenges for national water governance systems. It is in the definition of IWRM to perceive water governance as a multi-stakeholder process in which social, political and economic institutions and their relationships are regarded as important for water development management (Iza & Stein, 2009). Tackling the challenges such as those posed by political and institutional frameworks, financial constraints and environmental circumstances requires a coordinated effort among those who play an active role in water governance and those who are affected. This is particularly important at local levels.

[14] http://www.iucn.org/regions/west-asia/our-work/water-climate-change-programme/search

Good governance is a means to an end. It delivers beneficial outcomes for society, the economy and the environment (ecosystems). Good governance practices allow responding to the problems of today with policies that are consistent with the long term goals. An effective governance system is a mechanism to manage water in a sustainable, integrated and inclusive manner that will help tackle water challenges and make political will effective on the ground and at the community level.

Water governance is typically adopted through the following practices:

1. Principles of equity and efficiency in water resource and services allocation and distribution, water administration based on catchments, the need for integrated water management approaches and the need to balance water use between socio-economic activities and ecosystems, especially at local levels.
2. Principles that relate to creating ownership and accountability at different subsidiarity levels through stakeholder-led participatory approaches to planning, decision-making and implementation of water resources management.
3. The formulation, establishment and implementation of water policies, legislations and institutions that enable water management and water governance at different subsidiarity levels, notably at watershed and local community levels.
4. Clarification of the roles of government, civil society and the private sector and their responsibilities regarding ownership, management and administration of water resources and services at different subsidiarity levels, including the local community level.

2. Water and Climate Change

In the face of evolving climate and social challenges, there is an additional need to define key water governance challenges posed by climate variability and climate change to ecosystems and users of these ecosystems, in terms of their vulnerability[15], exposure[16] and sensitivity[17] to climate change. This will help to outline responses that will lead towards more adaptive water management. Evidence regarding the effectiveness of climate change mitigation and adaptation tools and practices is still emerging, but there appears to be increasing consensus with respect to components that make up adaptive water management.

This paper will focus on groundwater management in particular, given the important role the development and wise use of these water resources can play in the region R-KNOW operates in. In drylands such as those found across the MENA region, the focus on year-round availability of water has encouraged unsustainable groundwater abstraction and inappropriate forms of irrigation that make inefficient use of water, which in many cases leads to increased climate change vulnerability through land degradation and salinization (Davies et al., 2016).

Among other objectives, SWRM aims also to manage and mitigate climate change and extreme climate events. SWRM makes it easier to respond to changes in water availability because risks can be better identified and mitigated in the process of basin planning. When action is needed, stakeholder participation helps to mobilize communities and generate action.

[15] According to (Bates et al., 2008), vulnerability to climate change is the degree to which a system is susceptible or unable to cope with adverse effects of climate change, variability, and extremes. It can be determined by examining for instance the level of exposure to water stress and climate variability, and the degree of sensitivity and the adaptive capacity of a community or ecosystem.

[16] Exposure is defined (Bates et al., 2008) by the magnitude, character, and rate of climate change in a specific area. Exposure to climate variation is primarily a function of geography. For example, communities in semi-arid areas like the MENA region may be most exposed to drought.

[17] According to (Bates et al., 2008), sensitivity is the degree to which a community (or basin) is adversely or beneficially affected by climate-related stimuli. This mainly depends on livelihood activities, key livelihood resources, and impacts of climate hazards on these resources.

Water users can then be stimulated to use the resource sustainably in the face of changing water conditions. Challenges to implement SWRM that are specifically posed by climate change include:

- High levels of uncertainty and rapid and sometimes irreversible changes in the state of resources and ecosystems;
- The increasing need for inter-sector and inter-institutional coordination (including among levels of government) in an environment of weak law enforcement and outdated water policies;
- The role that healthy freshwater ecosystems and sustainability play in fostering adaptive capacity, both in terms of environmental and social resilience.

Participatory planning and decision-making approaches, such as those described at the end of this chapter, are key elements in building self-organization and ownership as components of a resilience framework for moving from dialogue on climate change to implementation of adaption action. Climate change manifests itself primarily through changes in the water cycle. Its impacts have direct consequences on water security and conflicts. To achieve development and water security at local levels, climate change adaptation will have to build on resilience. This resilience can be strengthened through healthy ecosystem services that rely on well-functioning river basins – and through their benefits for climate resilient development of the food and energy sectors. Ecosystems such as mangroves protecting shorelines from storms, lakes storing large water supplies and floodplains absorbing excess water runoff, are key parts of such strategies. These nature-based services perform infrastructure-like functions. Working with this 'natural infrastructure' can optimise the performance and financial benefits of engineered infrastructure.

3. The Water, Energy and Food Nexus

The "Nexus" can be defined as the place where water, food and energy security intersect. At its heart is a strong understanding of the interdependencies between these three resource systems. As a framework, this Nexus is being promoted for allocating and using water, food and energy for an ever-growing population at a time of climate change, land use transformation and economic diversification.

The here advocated nexus framework for action is about integrating management and governance across sectors and scales. There are undoubtedly synergies and trade-offs that arise from the way the water, energy and food sectors operate. Sectors do not operate in silos; they operate through public sector policies that are structured around water, energy and food production. The aim is to prevent creating new silos around issues such as ecology, carbon, soil, climate, etc.[18]

A nexus framework (see Figure on next page[19]) aims instead to identify interactions and connections as well as potential areas of conflict to support decision makers in identifying solutions. The interrelatedness between water, energy and agriculture should be used as an opportunity to tackle development challenges by a multi-sectoral approach.

Existing natural, social and financial resources are in many cases mismanaged, with subsidy programmes often representing an obstacle to conservation and efficient use of water, energy and land. In addition, lack of political will inhibits the need for changing mindsets with regard to

[18]http://www.waternexussolutions.org

[19] http://www.waternexussolutions.org

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Figure 2. Stakeholders Active in Mobilizing Nexus Solutions

top-down and "silo" approaches of management. More specific challenges for the application of a nexus framework to advance SWRM implementation in the MENA region include the lack of institutional capacity, cost/benefit sharing challenges, and potential transboundary disagreements.

Practically, a nexus paradigm challenges the current application of knowledge, and it highlights the need for greater integrationon core elements such as data collection, sharing, analysis and interpretation. Through dialogue, opportunities can be created to bring together people with a variety of experiences from across sectors, to brainstorm, and exchange knowledge, with the ultimate aim to move to developing and implementing practical actions.

It follows that nexus way of thinking is largely about governance within the three sectors and between their relevant value chains. It entails collaboration and coordination amongst sectors with a holistic vision and integrated planning, while notably action needs to be taken with regard to governance, sector policies (national and international), financial instruments, industrial development and innovation technology, and environmental assessment that value ecosystem services. This allows decision makers to develop the strategies and plans that contribute more effectively and efficiently to the achievement of sustainable development, and minimize the payback periods of investments. It can be achieved through better management of natural resources and ecosystems, i.e. IWRM, land resources management and a shift towards greater resources use efficiency.

4. Sustainable and Innovative Water Technologies

Under the present economic paradigm, innovation and technologies are primarily driven by the need for business to make profits and grow, frequently with little concern for social or environmental costs. It may be to the detriment of achieving sustainability, if we focus merely on making such innovative potential technologies more efficient and profitable from a narrow business point of view.

Challenges to sustainable water resources management have emerged or intensified due to population growth, the impact of climate change, the need to reduce greenhouse gas emissions in agriculture, increasingly costly water footprints, the rapid development of emerging economies and growing social instability associated with water, energy and land shortages.

Development of sustainable and innovative technologies[20] can be a major pathway to meeting these challenges without causing undesirable environmental and social damages. Such technologies have the potential to preserve the earth's ecosystems, limiting poverty, adapt to climate change, and related health and housing issues, while achieving a sustainable agricultural and food system, along with more employment and free time for all.

[20] We use here a definition that understands sustainable technology as a technology that provides for our current needs without sacrificing the ability of future populations to sustain themselves. With innovation we mean something new or improved (whether technology or otherwise) in products (goods or services), processes, marketing or organizational methods.

Nevertheless new technologies and innovations can pose their own specific challenges. For example, innovations are sometimes unreliable and imperfectly designed. The newer the technology, the less tested it is in practice, and the more likely it is to experience break down and/or be uncomfortable in day to day use. Availability of reliable funding also plays a main role in implementation as well as operation and maintenance. In small communities, new installations often break down due to financial constraints and insufficient technical support and follow-up. Social acceptance is not always ensured especially by those people who are used to traditional technologies. Moreover, natural conditions can limit the use of new technologies in some locations. Hence, to maximize the benefits of implementing sustainable and innovative technologies, these need to be technically viable, economically feasible, environmentally sound, and socially accepted.

This paper will illustrate some of such innovative technologies that are able to address local problems and meet local needs while contributing to improving overall social, economic and environmental conditions in a specific area. Sustainable and innovative technologies become more efficient and competitive if all stakeholders participate in capacity development and relationships are reinforced through their use.

Social Organization and Planning Approaches

Approaches and methodologies for water resources planning, innovation and social organization around water use and management revolve around stakeholder approaches for community involvement and empowerment, local governance capacity and participatory planning, as well as ensuring governmental commitment to actions and decisions. The different ecosystems in the sub-humid, semi-arid and arid lands, in short the drylands of West Asia and the Mediterranean region, provide important services and benefits to society; services and benefits that need to be nurtured, sustained, and if necessary restored. The approaches proposed for a participatory ecosystem approach to IWRM have shown to be apt to do so and create the long term impact necessary to make these actions a success, while rewarding both the ecosystems in which action takes place and the local people who are taking such action.

There are a number of principles underpinning successful implementation of such approaches that potentially can lead to social change processes that have sustained and replicable impact. They are shortly mentioned in Box 1, while being discussed in more detail in SPRING, another WANI publication on participatory ground water management.

Box 1.1. Principles for social organization in participatory ecosystem and water resources management

1: Include vulnerable groups
2: Include the environment as a "stakeholder"
3: Get the support of those in Power
4: Institutionalize the process
5: Facilitate respectful listening and shared solutions through open dialogue
6: Create ownership
7: Build capacity and perseverance
8: Know that a good social process is a good investment Source: (Laban, 2016)

In short, such participatory approaches to water resource planning, social organization and community empowerment can be summarized as in the following Box. They form the backbone of many of the case studies presented hereunder and have been applied both at community, watershed and governorate levels.

Box 1.2. Community empowerment and participatory stakeholder-led planning and decision-making

A participatory community development planning process for SWRM activities will follow an iterative approach, involving a number of Phases (see Figure 3).

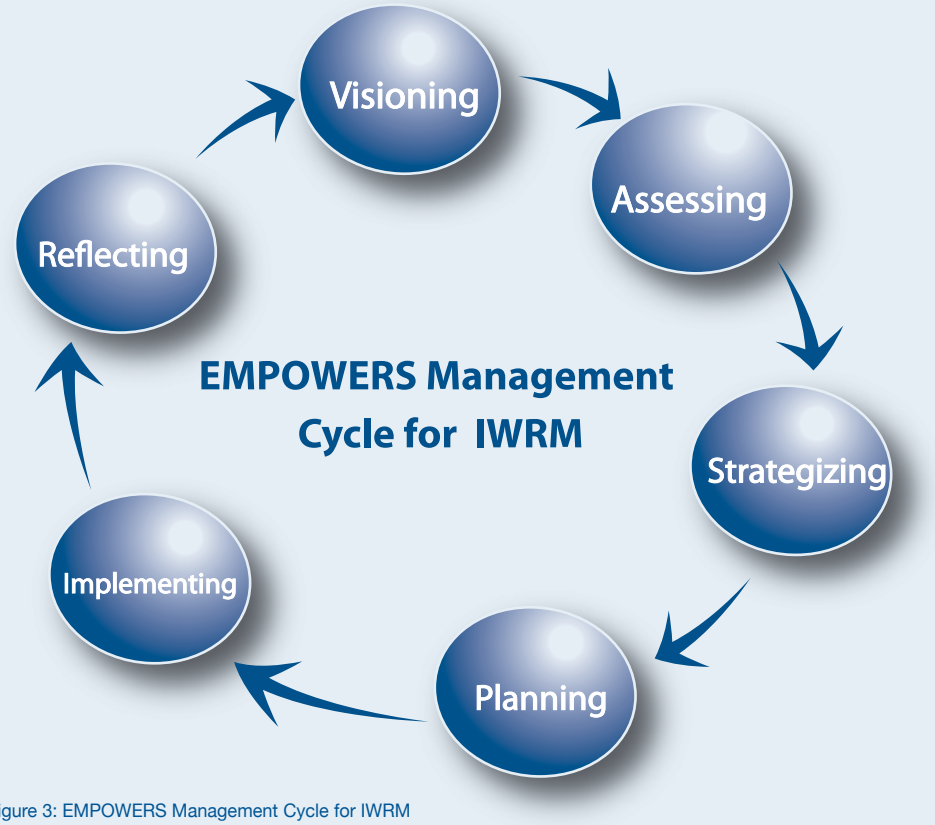

Figure 3: EMPOWERS Management Cycle for IWRM

→ ***Phase 1 - Visioning:*** *space and time is provided to reflect with communities on how they would see their village water situation on a somewhat longer horizon than the project period, probably 7 to 10 years. This vision, that needs to be realistic, concrete and factual, can be refined in a later state when more information and insights are acquired. The planning process will explore, in view of the proposed vision, who are the important actors that need to be involved in undertaking activities that will attain the vision (local stakeholder analysis). The participants in the process can then undertake a participatory analysis of the*

constraints and problems that stand in the way to attain such a vision. This can be done through problem tree analysis, that allows all, including the shy and less dominant people (and especially women and youth), to express themselves, without their opinions being side-lined by more dominant and assertive participants. This problem analysis will detect issues and areas that need further study or information, that will be gathered in a second phase of further data and information collection.

*→ **Phase 2 - Assessing:** The assessment phase will provide more information and new insights that can be used to refine the provisional vision developed at the outset of the planning process and engage the participants in scenario and strategy building and consequent more detailed planning of activities.*

*→ **Phase 3 – Strategizing** where first scenarios[21] are developed under which the above visions can be realized. In such scenario building the factors will be determined that may constrain achieving the vision (water scarcity, access to water resources, local community organization, legal constraints, irregular rainfall, etc). On the basis of the most important and most uncertain factors this results often in two or three scenarios that describe the most unfavourable, the most realistic and the most favourable situation at the end of the planned time horizon. Under these scenarios strategies need to be developed to attain the above expressed vision. Scenario building forms an important step for exploring the uncertainties that have to be faced and to be taken into account in the planning process. This will provide a good basis for developing strategies and prioritizing activities and interventions. A critical step is to come to a shared strategy to attain the vision developed and refined earlier. It is critical that this strategy or strategies are shared by all stakeholders, both by the owners of the process, that are the residents of the local communities, but also by the key actors, government agencies and others, who have to support and enable the activities to be undertaken. Sharing and agreeing on such a strategy will form a way to make reality checks (is it possible and feasible) but also as the adopted guideline for further action. The strategies will identify the key domains of intervention that have to be further worked out. **The EMPOWERS Approach to Water Governance: Guidelines, Methods and Tools** (Moriarty et al., 2007) provides further detail on how such scenario building and strategizing will be undertaken on the basis of clear methodology outlines that are developed for this purpose.*

*→ **Phase 4 - Planning:** The planning phase will develop in detail the activities to be undertaken, responsibilities of tasks and actors, budgets and other operational details.*

*→ **Phase 5 and Phase 6** deal with **implementing** and the learning process throughout the different phases of the management cycle of **reflecting**, monitoring and learning.*

Due attention, also in such a community planning process, needs to be given to necessary investments in resources and technologies and to externalities (impact outside the ecosystem where on the ground action takes place) to the benefit of others than those investing directly in the ecosystems at stake. Phase 3 on Strategizing is particularly suited to do so.

[21] *Scenarios are defined here as descriptions of a future state of affairs, for instance at the time horizon for which the vision is developed.*

Enhancing Local Water Governance within a Water, Energy and Food Nexus

Relatively renewed attention is given to the need to plan, manage and decide on water resources, while addressing the interaction with closely related sectors, such as the energy and agriculture/food production sectors. Where it is obvious that these three sectors are tightly related to each other, narrow sector targets have often pushed their often critical interactions out of sight. Without water no food production and without attention to energy requirements and inputs often unsustainable water management. The political need to revisit these interactions and integrate the management and governance of these three sectors has been captured under the umbrella of the water, energy and food nexus, to which easily can be added the need to manage resources from the perspective of strengthening resilience of natural resources and livelihoods to adapt to and mitigate climate change patterns.

Meeting SDGs through Sustainable Water Resources Management

The actions under the different dimensions or thematic areas introduced above and illustrated in the following chapters, all contribute directly and actively to meeting important Sustainable Development Goals among the 17 SDGs that were adopted by the UN General Assembly in 2015. Implicitly or explicitly the case studies described in the following four chapters deal or target SDGs such as SDG 5 "*Achieve gender equality and empower all women and girls*" through adequate local water governance, SDG 6 *"Ensure availability and sustainable management of water and sanitation for all"* through good local water governance and innovative sustainable technologies, SDG 13 *"Take urgent action to combat climate change and its impacts"* by closely linking water resource management and climate change resilience, and while all actions as described in this Knowledge Book contribute directly or indirectly to SDG 15 "*Protect, restore and promote sustainable use of terrestrial ecosystems, sustainable manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss"*. The case studies in the chapters below will underline implicitly or explicitly how important local water governance, sustainable and innovative water technologies, clearly linking SWRM with climate change resilience are for meeting the SDGs.

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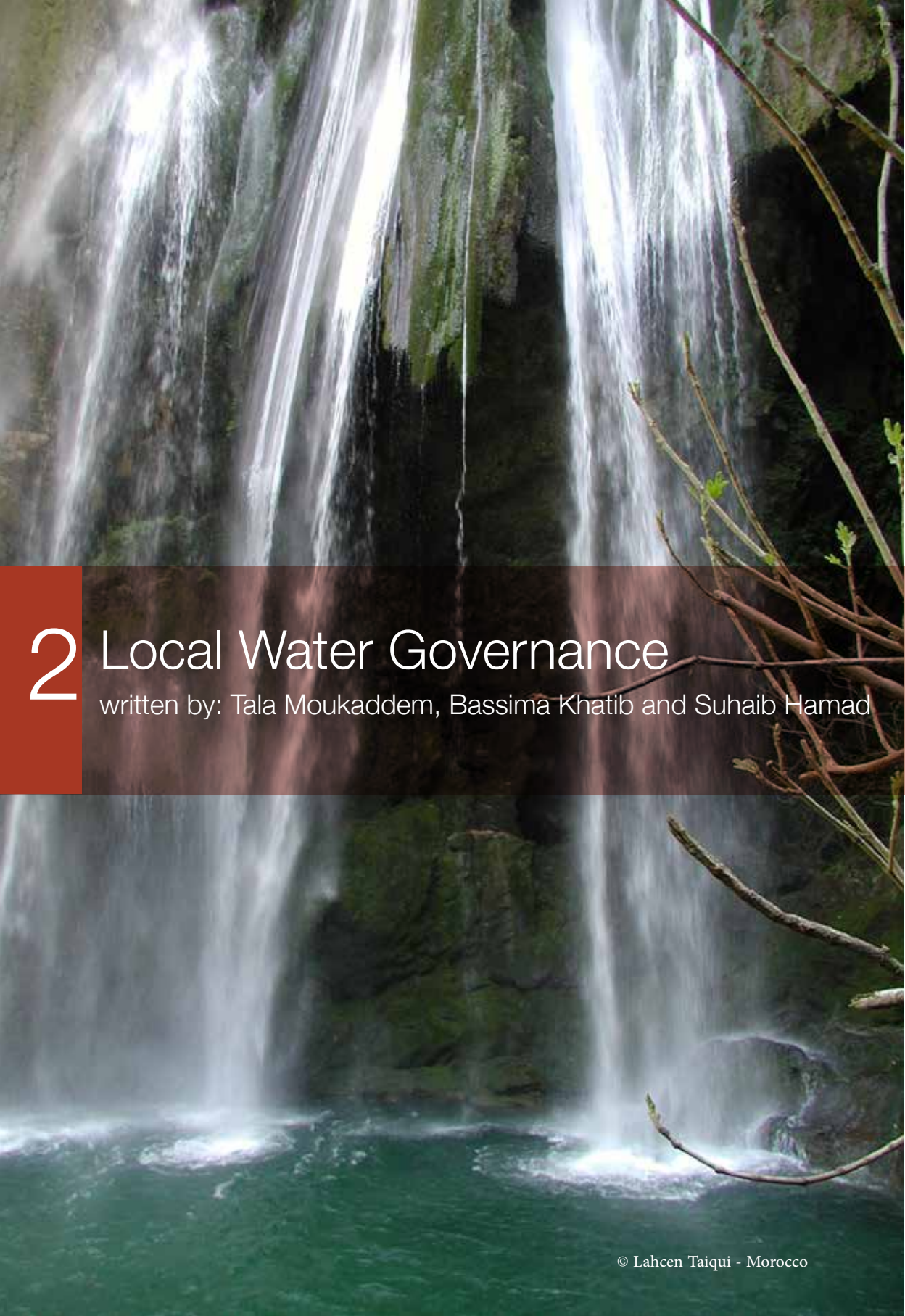

2 Local Water Governance

written by: Tala Moukaddem, Bassima Khatib and Suhaib Hamad

2. Local Water Governance

There is increasing recognition that the active involvement of the local users and beneficiaries of water resources is a prerequisite to operate and sustain integrated water resources management (IWRM) policies and practice. Empowerment, participatory planning and social organizat ion of these direct water users are part and parcel of local water governance approaches that not only consider the water resources as such but also how water flows and use determine the health of the broader ecosystems they are part of. The first section of this Chapter will illustrate how hydrological flows determine the sustenance of a marsh ecosystem rich and unique in biodiversity in the Beka'a Valley of Lebanon and how the good management of water resources and related ecosystems can be enhanced by local water governance practice and social organization, also in view of imminent climate change threats. The second section illustrates how a long-term process of building capacities of Water User Associations and the related local water governance practices have proven to be a key for the sustained management of the scarce water resources in the Jordan Valley. Another short case study complements this Chapter and is situated in the Jordan highlands dealing with local water governance in view of degrading ecosystems and necessary adaptation to climate change.

2.1 Restoring Hima Ecosystem Functions though Promoting Sustainable Community-based Water Management Systems, Lebanon

The Bekaa Valley, Lebanon

Short Description of the Catchment Area

Water demand in Lebanon is not only affected by physical water resource conditions, but also by complex familial, sectarian and political inter-relations, where water scarcity can easily provoke conflict. Anjar and Kfar Zabad are two villages on the level plain of the Bekaa valley with high biodiversity due to their richness in water resources.

In the water catchment in which these two villages are situated, one of the few remaining marshlands in the Middle East is found. Fed by rivers and springs, it has created a typical habitat for African Eurasian water birds (Figure 1) and breeding habitat for globally threatened Syrian Serin. This has led the Society for the Protection of Nature in Lebanon (SPNL) and BirdLife International in 2005 to declare these marshlands as an Important Bird Area (IBA). The area was also declared as a Hima[1] (community based management system) by SPNL and the municipalities of Anjar and Kfar Zabad, due to its high biodiversity and livelihood values.

The marshlands sustain the livelihood of the surrounding farmers and fisheries and provide drinking water to over 30 villages in the surrounding area. Anjar's economy relies mainly on farming and agriculture, with 70% of its population (2,500) being farmers. Gravity irrigation, which is considered to be significantly less efficient than drip irrigation due to high water losses, is the most common method used for surface irrigation as it accounts for 64% of the total irrigated areas. Up to 80% of all available water resources are consequently consumed in Anjar.

The area suffers from degradation of its water resources leading to the destruction of the present biodiversity and to serious problems in water quality and quantity. Noting that agriculture represents the major income generating activity of the local community, this dependency is leading to the over extraction and misuse of water resources from the springs, wetlands and

[1] Al Hima (الحمى) is an age-old traditional institution of tenure which has governed rangeland resources in the Arabian Peninsula for over 1500 years. In doing so, Himas have contributed to the sustainable management and conservation of vast areas of rangeland and natural resources.

underground wells, the use of inefficient irrigation methods (flood irrigation, sprinklers etc.), soil salinization due to poor drainage, and the overuse of chemicals and pesticides. This is further aggravated by climate change stresses. These degradation processes impact negatively the surrounding habitat and puts it under a major threat.

Figure 4. Anjar Kafr Zabad Wetland

In Kfar Zabad the problem of water over-exploitation and degradation of ecosystems and their biodiversity is aggravated by the absence of an organized water institution that assures the efficient distribution of water shares without leading to any conflicts. This is different in Anjar where the presence of the Anjar Water Users Association (WUA), established in 1935, assures the management of Anjar canal water distribution system that provides water through gravity from Anjar spring to the downstream agricultural lands. The strong governance structure of WUA assured the distribution of water shares in an equitable manner, thus preventing water conflicts over the available water resources.

The WUA management board is elected on a yearly basis to represent the farming community, and has a few seasonal staff to take care of canal maintenance and to patrol the fields against thefts of water. The WUA offers its services to all the farmers who practice agriculture within the canal system at a reasonable price. These services include organizing irrigation from source to user, monitoring operation and maintenance, budgeting and reporting to the municipality, and managing conflict between farmers.

The following problems were nevertheless highlighted as major threats to the area and its Hima ecosystems. The open earthed canal network structure decreases the efficiency of the system system and causes important water losses from evapotranspiration and leakages, while the cleaning of earth canals, necessary on a yearly basis, results in high maintenance cost. Moreover, irrigation of crops is done by land flooding techniques regardless of crop needs. Furthermore, there is no management and monitoring system as well as database to manage the amount of water pumped to the agricultural lands as a function of crop needs. This has further decreased the efficiency of the system. In addition, apart from potential conflicts over water shares, it was sensed that the communities of Anjar and Kfar Zabad have limited awareness about water conservation and sustainable agriculture practices and techniques,

and about the close links between the value of sustained ecosystem services and the sustainability of their livelihoods. Moreover, there is little enforcement of water policies to manage water and agricultural practices. It is in view of above considerations that SPNL, the Municipalities of Anjar and Kfar Zabad and the WUA engaged in the project described below.

Water Resources Management and Governance Processes

The project aims to restore ecosystem services and improve the management of water quality and quantity used for agriculture in the Hima's of Anjar and Kfar Zabad through promoting sustainable community-based water management systems of wells, wetlands and canals for agricultural use. At the same time it aims to improve the valuation and appreciation of the Hima water ecosystems in Anjar and Kfar Zabad IBA for people and nature. To achieve these objectives the following strategies were lined-out by the project:

1. Improvement of water infrastructure, management and monitoring in Anjar
2. Implementation of agri/environmental awareness campaign in Anjar and Kfar Zabad
3. Igniting wise water management in Kfar Zabad

Improving infrastructure and management meant restoring the old canal irrigation system that has been managed by the governance structure in place, i.e. the WUA, so as to minimise losses from seepage and, in turn, making it financially viable for farmers in the drier areas to access new sources of irrigation water other than artesian wells. This went hand in hand with water allocation to farmers through a set of water quota, and the instalment and operation of water sluices to manage water levels in the wetland, prevent flooding of surrounding agricultural land and meet biodiversity rehabilitation targets.

Replacement of flood irrigation by furrow irrigation was promoted by lowering water fees for farmers adopting furrow irrigation and providing needed tools and equipment. Extension services were provided to improve farmer knowledge on water management and sustainable agricultural practices based on crop needs. Poor water quality as a result of using chemical pesticides and fertilizers was tackled by extension services to farmers.

The project provided an opportunity to improve the management and monitoring structure of the canal system, by strengthening and equipping the WUA to improve its efficiency in minimizing water losses and better managing available water resources. Reformation of the WUA and establishment of a WUA in Kfar Zabad were advocated throughout the project. Also, the 'Hima' approach was revitalized, which is a 1,500-year-old traditional community-based approach used for the conservation of sites, species, habitats, and people in order to achieve the sustainable use of natural resources, including water, through the community where each has a defined role. The designation of Kfar Zabad & Anjar as a Hima had come through a municipal council decisions in 2005 and 2008 respectively.

An agriculture environmental awareness campaign was carried out in the area to highlight the value of this ecosystem (which is also a World Heritage site that receives more than 40,000 visitors annually) for water management and flood control, and its implication on the livelihoods of the farmers and other villagers. This double-edged strategy was aimed at raising the capacity of community members organized in Site Support Groups (SSGs), farmers and WUA to use scientific tools and technologies for water management as well as their knowledge of

sustainable agricultural practices such as drip irrigation and fertilizer input based on actual crop needs. This is necessary to more permanently curb water shortages and limit pollution, which are the direct threats to the ecosystem. The SSG members will become leaders on environmental awareness and education in the agriculture community and surrounding villages, notably on agricultural pollutants and water quality management. Furthermore, SSGs will have a lead role in highlighting the linkage between the water ecosystems, the world heritage site, and livelihoods. SSGs will also be involved in awareness raising through the ecotourism packages that will be prepared, linking Anjar and Kfar Zabad Himas together and thus, harnessing the value of biodiversity and its ability to contribute to boosting livelihoods, resulting in income generating activities. The role of children, youth and women was empowered by establishing a committee from the youth and women of both villages to lead on raising awareness about improved water resources management in the two villages. Furthermore, an educational program was established (including hands on activities) to involve kids in nature interpretation and attract them to participate in water saving and biodiversity conservation.

The municipality of Anjar was encouraged to play a major role in setting-up and applying local policies for the management of water quality and quantity alongside the WUA. The project supported the municipality with the necessary information, man power and database in order to issue management policies, also to comply with the policies of the Ministry of Agriculture (MoA) for limiting agricultural pollutants. Furthermore, the municipality was provided with the necessary equipment to monitor water quality and quantity in collaboration with the WUA of Anjar, and thus have a set database which allows it to issue policies accordingly. Support by an extension service agriculture engineer helped the municipality to guide and monitor water practices and provide recommendations for sustainable agricultural practices. The good example of Anjar was used, through a number of exchange workshops and meetings, to set-up a platform for good local water governance in Kfar Zabad Municipality in addition to the establishment of a WUA.

Resulting Innovative Approaches and/or Technologies and Expected Project Impact

As a result of the application of a management strategy for Anjar canal system, water management for agriculture is expected to be improved. The income generated by the WUA from maintenance savings will make it possible to invest in the construction and improvement of public canal infrastructure, notably for farmers who possess agricultural lands outside the direct canal domain. This alternative irrigation source is cheaper than the current water they buy from distributors. Having to pay less for irrigating their lands will enable farmers to invest in other sustainable environmental income generating activities. The increased use of the spring/canal system for complementary irrigation will lessen the negative impact of over drilling of water from the downstream aquifer for agricultural purposes. This will also lessen pumping from artesian wells and hence improve spring flow to aliment the marshland Hima. Thus, this is expected to improve the status of the different ecosystems in the Hima IBA site.

The enforcement of the municipality policies is expected to result in controlled use of agrochemicals and water quantities based on crop needs. This is expected to improve the quality of agricultural products and to be more environmentally friendly. Farmers can benefit from this asset (environmentally friendly products) in better marketing their crops and increasing their income. The municipality's policies will, in the end, reduce the threat of degradation of biodi-

versity and of the Hima ecosystems while improving water quality and quantity. The result of the application of the awareness strategy and an ecotourism plan is expected to raise appreciation of the local population for their Hima ecosystem and contribute to better practices in relation to water quality and quantity.

This project was deemed highly relevant to the Regional Knowledge Network on Water (R-KNOW)'s water and governance theme for adopting a participatory and local governance approach embedding its focus on infrastructure management. The project highlighted innovation and sustainability because of the efforts to replicate the already established WUA model in one municipality to another. It also demonstrated its potential for ecological, financial and institutional sustainability.

Best practices for the ecological sustainability of this intervention included ensuring increased quantity and quality of water, thus increased crop productivity and value, as an incentive to encourage farmers adopting environmentally friendly farming and water conservation practices. Also monitoring the impacts of the project was introduced through set indicators which reflect project outcomes. Financial sustainability is enhanced by restoring the effectiveness of WUAs and consequently reducing maintenance cost of the water network. This will increase the willingness of farmers to pay their fees for water services. Institutional sustainability was enhanced by closely involving the two municipalities of Anjar and Kfar Zabad, strengthening their governance structures and adopting water allocation and financial and monitoring plans that are agreed within the local community. Additionally, the project strived to revise and reform current policies on water management and agricultural practices through policy reform workshops with stakeholders (mostly farmers) from multiple levels of governance and sectors.

Lessons Learnt

A number of important lessons can be drawn from this case study. This concerns notably methods for community based management, the ways to engage local people and the importance of caring for ecosystems. This will be further discussed in the final Chapter 6 of this knowledge book.

2.2 The Highland Water Forum (HWF): A Multi-Stakeholder Dialogue for Sustainable Groundwater Management, Jordan (written by: Eng. Reem Al-Qaissi, GIZ)

Jordan's groundwater resources make up 57% of the country's total supply and water scarcity has led to significant competition between different sectors, mainly agriculture and drinking water. Irrigated agriculture uses more than half of the groundwater that is abstracted. While 10 out of the 12 groundwater basins found in the country are overexploited, safe yield in the Azraq groundwater basin is being exceeded by more than 220%.

In May 2010, the Ministry of Water and Irrigation (MWI) of Jordan established the Highland Water Forum (HWF) to enable water users from various sectors and decision-makers to meet, discuss and agree on policy recommendations for more sustainable groundwater management in the Jordan Highlands. Through this multi-stakeholder dialogue mechanism, the HWF is meant to be the official umbrella for Basin Committees in Jordan. Its core principle is good governance of water resources through stakeholder participation.

The Basin Committees are consultative bodies for the water governing authorities in Yarmouk and Azraq, with the ultimate task to elaborate action plans for sustainable (ground) water resources management and follow up their implementation. As an institutional unit within the MWI, the organizational structure of the HWF would enable the ministry to implement the National Water Strategy with regard to public involvement in sustainable management of groundwater resources.

The main achievements of the HWF so far have been the development of the Azraq Groundwater Management Action Plan and the Yarmouk River Basin Management Action Plan. Both action plans were endorsed by the MWI in February 2014. The main areas of intervention in the action plans are on-farm water use efficiency, alternative income opportunities, community development and providing the legal and institutional framework conditions.

A feasibility study for the establishment of a financing mechanism for the HWF was conducted to identify scenarios for the proposed financing structure. The study analysed the technical, legal and administrative conditions for establishing such a fund. The most achievable scenario is to establish a Fund Management Unit (FMU) under the MWI. In parallel to the establishment of such a structure, interested donors will be able to support the implementation of the Azraq/Yarmouk Management Action Plans through bilateral agreements with the MWI to finance individual activities directly.

Illegal water abstraction continues as a major challenge despite the judicial and executive arrangements to end it. The number of farms and total cultivated land in the Azraq Basin has been increasing constantly over the last 30 years despite the prohibition of founding new farms and the many different investments to make existing farming systems more sustainable and productive. Over abstraction (in majority illegal) of ground water is often a by-product of land grabbing.

The HWF should provide now an opportunity for the Basin Committees to start an open and transparent discussion around real cost of water. The role of academia and civil society in the HWF needs also to be strengthened to shoulder responsibility for awareness raising and advocacy with the public opinion. Concerned stakeholders can be empowered to become responsible counterparts for the water-governing authorities and advise on water resources management.

The longer-term vision of the HWF is to institutionalize the Secretariat at the MWI, to establish the HWF financing structure for the HWF, to implement the participatory water resources management action plans, and to establish new Basin Committees in other areas of the Highlands.

2.3 Water User Associations: The Key for Water Resources Management, Jordan (written by: Eng. Ghadeer Al-Mhaissen, JVA)

The Jordan Valley, Jordan

Introduction and Background

The Jordan Valley was always called the “vegetable basket of Jordan”. This denomination, however, has been getting challenged in the last decades by continuous stress on water resources and increasing scarcity of water for agriculture. Municipal and industrial water needs in the mountains have been increasingly met at the expense of water for agriculture in the

Jordan Valley. To revive the Jordan Valley's agricultural performance, several programs were implemented, that have led in 1977 to the establishment of the Jordan Valley Authority (JVA). JVA was mandated to manage the water resources and the socio-economic development of the valley. In the early years it achieved great success and showed an excellent model for the management of bulk water. Retail irrigation water distribution, however, faced a gradual decrease in efficiency, due to increasing maintenance cost and the deterioration of the network, in addition to several droughts since 2000. As a result farmers lost faith in the efficiency of the JVA and mistrust led to the lack of cooperation among farmers themselves. JVA was gradually overwhelmed with bureaucratic processes and lack of resources to manage the situation. This eventually led to jeopardizing the agricultural performance in the valley on one hand, and deteriorating the retail water distribution system on the other.

To reclaim the situation and to revitalize agricultural performance, JVA decided in 2000 to introduce more participatory approaches for sustainable water resources management for irrigated agriculture. The goal was to increase efficiency for irrigated land in the Jordan Valley. This initiative went together with the amendment of the JVA law which resulted in aligning much of the socio-economic development duties and responsibilities of JVA to the concerned line ministries, focusing JVA's mandate more on water management and distribution. This new mandate coupled with the need for farmers to see change, provided a fertile -though challenging - ground for a project for participatory irrigation management that was started to support JVA in developing its new mandate.

In essence the project built on traditional concepts of managing irrigation water jointly by farmers as was practiced long before the formation of the JVA. A small community of farmers having access to a source of water would get together in a kind of water user group and manage the use of the water resource according to a traditional social control system. This traditional management concept was built on shared ownership, interest and thus responsibilities towards optimum performance. It illustrated the essence of good water governance "avant la lettre" leading to openness, mutual trust and confidence among the farmers groups and between the farmers and the authorities.

The participatory irrigation management project aimed to develop functional organizational structures and technical improvements for the water distribution systems. With more sophisticated agriculture, involving technologies for water irrigation distribution that include high pressure pumping and the associated maintenance, it became imperative to organize farmers in Water User Associations (WUA), while action plans were made to build awareness on problems and potential solutions.

However, important challenges had to be faced as was revealed by an initial social study to better understand the opportunities and constraints for farmer participation and the development of WUAs. Inspiring changes in attitude, behavior and management would not be easy for the project, especially because historical social disparities and mistrust had accumulated over quite a number of years. Challenges that development of more participatory irrigation management had to face were, amongst others:

- Mistrust among farmers and resistance to change;
- Influence of large farmers, having access to sufficient water amounts and therefore not being interested to change the status-quo;

- Worn out supply and distribution network; high leakage, illegal connections, and inability to undertake maintenance to the network;
- Severe shortage of water resources, changes in quality, and the diversion of much of the available fresh water to Amman for drinking purposes;
- Absence of an adequate legal framework for farmers' participation in irrigation management

The survey also shed light on next steps and means to handle issues taking full consideration of the social dimension. The study revealed that there still is potential (even if rather low) for farmers to accept each other, and that farmers expressed high and urgent demands for JVA to improve the poor situation and work on more efficient water management. They also considered it important for JVA to undergo important reform, being aware of the urgency of water associations obtaining legal status. At the same time they insisted on more capacity building and incentives.

This section is the result of a special documentation study, undertaking interviews with different actors, describing their experience and the most important processes followed and different steps taken in the past 15 years to make WUAs in the Jordan Valley a reality.

Ecosystems and Social Organization Systems

Improved water resources management for irrigated agriculture is also important for preserving the dryland ecosystems in the Jordan Valley. Water and hydrological flows, in the Jordan Valley closely related to ground water springs and water that is coming from the upstream Yarmouk River watershed, are often highly determining the well-functioning of ecosystems downstream. Indeed each action that takes place in an ecosystem, here the valley bottom lands of the Jordan Valley, has an impact on surface and ground water, while well-functioning hydrological flows guarantee that other ecosystem services can be provided. Such ecosystem services can include higher biodiversity, soil fertility, carbon sequestration, quality of drinking water and its health benefits. For ecosystem management it is also important to consider the social organization dimensions such as stakeholder concertation, public participation, an experimental and 'learning-by-doing' approach to resource management. The case study below will illustrate how such social organization processes, i.e. those that led to the development of functional WUAs, are important for restoring agricultural productivity, for maintaining hydrological flows, preserving water resources and in the end maintaining ecosystems and their services.

Farmers Participation via Water User Associations; the Process Adopted

In view of the challenges described above, and in order to make change possible in managing water resources, an open, transparent and flexible process was engaged in 2001 to get a comprehensive understanding of the local issues including traditions, socio-economic aspects and the problems and difficulties facing the farmers. This was done through a series of meetings among the project team, the farmers and JVA. Since mutual confidence was mostly lacking, a priority for the project was to rebuild trust among the farmers, the project team and JVA. In doing so it opted for a structured step by step approach in responding to the existing problems. This included concrete activities to contribute to technical upgrading efforts like providing equipment and facilitating maintenance work to the water distribution network in a speedy way, but also awareness raising and human capacity building. The aim was to develop a participatory approach that could lead to the formation of different types of water user associations.

That such participatory approaches can be effective was demonstrated by sharing experiences from other countries and associations. Field visits were conducted in the south of Jordan, Syria, Turkey and Egypt where strong WUAs have proven to be successful. This has helped hesitant farmers to embrace a more serious and committed participatory approach and boosted their belief in putting such approaches to practice and sharing knowledge among themselves and with JVA staff. It is interesting to note that farmers covered most of the costs for such visits themselves and participated a great deal in the technical upgrading work. Thus such activities were not solely project driven, but reflected farmers' interest and commitment. To demonstrate the commitment of the project to such participatory approaches it facilitated mutual planning meetings with farmers and the top management of JVA.

The change process took a step by step approach through different phases, leading from disparity to unity and trust. Breaking the ice, bridging the gaps, developing mutual trust and confidence were imperative activities. General assemblies were paired with workgroups, brainstorming and planning sessions, in addition to face to face meetings for handling problems and difficulties. The facilitation of technical support was vital to demonstrate reliability and good intentions of the initiative. The formation of WUAs in a democratic approach and consultative procedure together with granting more formal recognition to WUAs so as to empower them in a timely manner were successful strategic steps. The participation in the project was not limited or restricted to any form of social level or background. The participation was among small and large farmers, rich or poor and of mixed origins.

The above activities have led to the successive built up of personal capacity and knowledge, and confidence and ownership for working together to solve problems. An iterative continuous learning-by-doing loop process paved the way for new institutional procedures and associations utilizing experience gained earlier in the process. When the project gained the support of both farmers and JVA, it started to do further work on developing suitable forms of water associations in the pilot study areas in the north, middle and south of the Jordan Valley. To do so, routine and subsequent meetings with the farmers were undertaken to initiate the process. The scope of potential WUAs was developed by the farmers, members of the WUAs were identified, and the leaders of the WUA were selected by the members. Moreover, efforts were made with JVA to ensure legal status of the WUAs and allow them to exercise a certain form of power and influence on decision-making.

Social Organization Achievements

By the end of the first phase of the project in 2003, 9 water use associations were formed: 6 water use committees, 3 water councils, and 1 water use cooperative. Based on this success follow-up work resulted in reaching 21 associations by October 2009.

Through the project the WUAs and the JVA established a partnership for the efficient water use in irrigation. WUAs became recognized by JVA and contracts were made between JVA and the WUAs that resulted in higher ownership in water management and responsibility for the distribution of irrigation water. Depending on performance, the JVA transferred tasks to the WUAs for retail distribution of irrigation water, with shared responsibility between JVA and WUA. In other words, the WUAs gained the respect of the JVA, where they are looked upon as the preferred outsourced private (non-for-profit) community arm to guarantee proper services to farmers, members of the WUAs, with regards to distribution of irrigation water. At the same time the JVA improved its image among WUAs with the JVA management support being

a key element for WUAs to succeed. Working in a participatory mode was like a partnership for a shared goal. WUAs have now direct access to the Secretary General of JVA and his deputies. Their requests are well considered and they are respected as strategic partner in the water distribution management. In short, the farmers became more powerful stakeholders in sustainable water management.

Box 2.1. Different forms and status of WUA's

In the Jordan Valley WUAs are classified according three distinct levels, reflecting their more or less formal status:

Water User Committees (WUC): Similar to the traditional form of farmers' management that existed before the formation of JVA, a WUC is a group of representatives of farmers elected by the farmers in a general assembly after several informal meetings.

Water Councils: Recognized by the JVA, they are based on traditional mechanisms of problem solving. Each council would have 15–20 elected farmers chosen by the concerned farmers. The Government is represented through the sub-governor (Al Mutassarif) who may even "chair" the Water Council, thus providing it more executive power.

Water User Cooperatives: They are associations that have legal status. Cooperatives follow the Cooperation Law No. 18 / 1997 and thus they are affiliated to the Jordan Cooperative Corporation (JCC). They must have their internal regulatory system that specifies the objectives, capital, membership procedure and financial and administrative issues[2].

Many members and leaders of the WUAs reported that they are very satisfied with the results and recommended adopting such participatory approaches for future generations and other farmer communities. For an important part this is because the process is perceived as being based on fairness, while matching well with the traditional approach and religious principles of water management. That is why by 2009 more than 75% of the Jordan Valley irrigated farm lands have become covered by WUAs, to which irrigation water distribution tasks are granted while operating in a successful manner. Farmers' satisfaction has reached high rates; 95% of the farmers are well served with water in 2009, while in the past only 5% were benefiting; full coverage will soon be achieved.

WUAs' members have gained professional skills in organizing meetings, presentation of their ideas, taking minutes of meetings, and preparing agendas. The farmers and associations have also increased their knowledge in facts and figures, through the awareness on the water situation, strategies and demand management. The increased level of farmers' participation, democracy, and professionally expressing their views, as well as improved communication and management skills are important achievements too. Moreover, a clear increase of volunteering spirits for the sake of community service among many WUA was obvious. This level of dedication paid back positively on the image and reputation of the communities. Also the role of women in irrigation management gained more respect; their role in some WUAs as farmers in the communities was well pronounced. This helped in getting more equal rights for women participation in irrigation management.

The work on forming WUAs was certainly not easy and many difficulties and challenges had to be overcome. Yet when the participatory approach was implemented, it resulted in a number of success stories (see Box 2.2. next page) and positive impacts. Such impacts included

[2] Until recently the JCC was the only body that could register water cooperatives. In 2010 the project has taken the necessary steps in cooperation with JVA to prepare bylaw, by which the registration of a WUA will become governed and a well clarified process for registration established.

improved productivity, fair water distribution and reduction of illegal water use due to higher availability on a regular basis. The change from complete reliance on JVA of farmers with negative attitudes and perceptions to the full and responsible transfer of distribution tasks, form a proof of success for the cooperative work between WUAs and JVA. To ensure the sustainability of the experience for the long term, a bylaw will be set in the near future to govern the holistic relationship among the WUA, JVA and other stakeholders. This is expected to happen through the establishment of a federation for the WUA and a corresponding unit at JVA.

Success Factors and Lessons Learnt

Important Success Factors

(i) A bottom-up, step by step approach was a remarkable factor for the success of the project and for increasing ownership of farmers and WUAs.

(ii) This approach, strongly pursued by the project, has generated trust along the march of the project, respect for and commitment to WUAs by the JVA, and readiness and dedication of the farmers.

(iii) Farmer cooperation and the good and well-managed control by the WUA for organized water allocation have led to fair and equal distribution of water, while

(iv) Project staff, stationed in the field and in regular communication with farmers, was highly appreciated by the farmers and the WUA.

(v) The support of JVA directors was crucial in adopting a more open approach to management and a long term vision. Indeed, the appointment of Deputy Directors to the Secretary General for the North, Middle and South Jordan Valley was a wise step which ensured availability of high level decision makers, thus enabling speedy actions in semi decentralized management processes.

(vi) The regional technical visits (info-trips) were beneficial not only from a technical point of view but also by creating an atmosphere of cooperation, exchange of ideas and business practices. This has improved the performance of the farmers and allowed for collective thinking.

Box 2.2. Al-Kafrein, a success story

Direct savings of water resources were achieved in two months after handover by JVA of water distribution tasks to the WUA in Al-Kafrein. The community was able to optimize the irrigation scheme, reduce leakages and illegal connections to the network, and thus reduced the water released from the dam to the network from 12,000 m^3/day to 6,000 m^3/day. The success in Al Kafrein was achieved in an outstanding short time, although it is one of the areas that suffered much of illegal water use and of an almost completely damaged irrigation system. After working as a water council, it formed a cooperative in November 2006, while the complete transfer of tasks was achieved by February 2009. The WUA reported that productivity of their farms has undoubtedly increased as the water became available in a more systematic way and the crops were irrigated according to a set schedule. Effective trouble shooting by the WUA ensured that problems in the system were resolved immediately so that the farmer did not miss his turn to and share of irrigation water. In addition, the availability of reliable irrigation management encouraged farmers to expand their farm areas and some to invest in farming business.

The case of Al Kafrein is an example of project management not choosing easy ways just to document success. Some WUAs were established in the most difficult areas as in Al Kafrein facing a lot of inefficiencies and troubles in irrigation water management. Now the Al Kafrein WUA marks one of the top records of success. This had great impact on the effectiveness of participatory irrigation management, and encouraged other associations to follow the track. The overall approach contributed importantly to rebuilding trust in the Jordan Valley agricultural sector.

Lessons Learnt

Important lessons are learnt from this case study as well. This concerns documenting what you are doing and the value of participatory approaches. Dealing with local people in a transparent and serious way is providing interesting results. Communication and cooperation remain critical assets for these processes to be succesful. More detail will be given in Chapter 6 on what has been learnt from working in the field with farmers.


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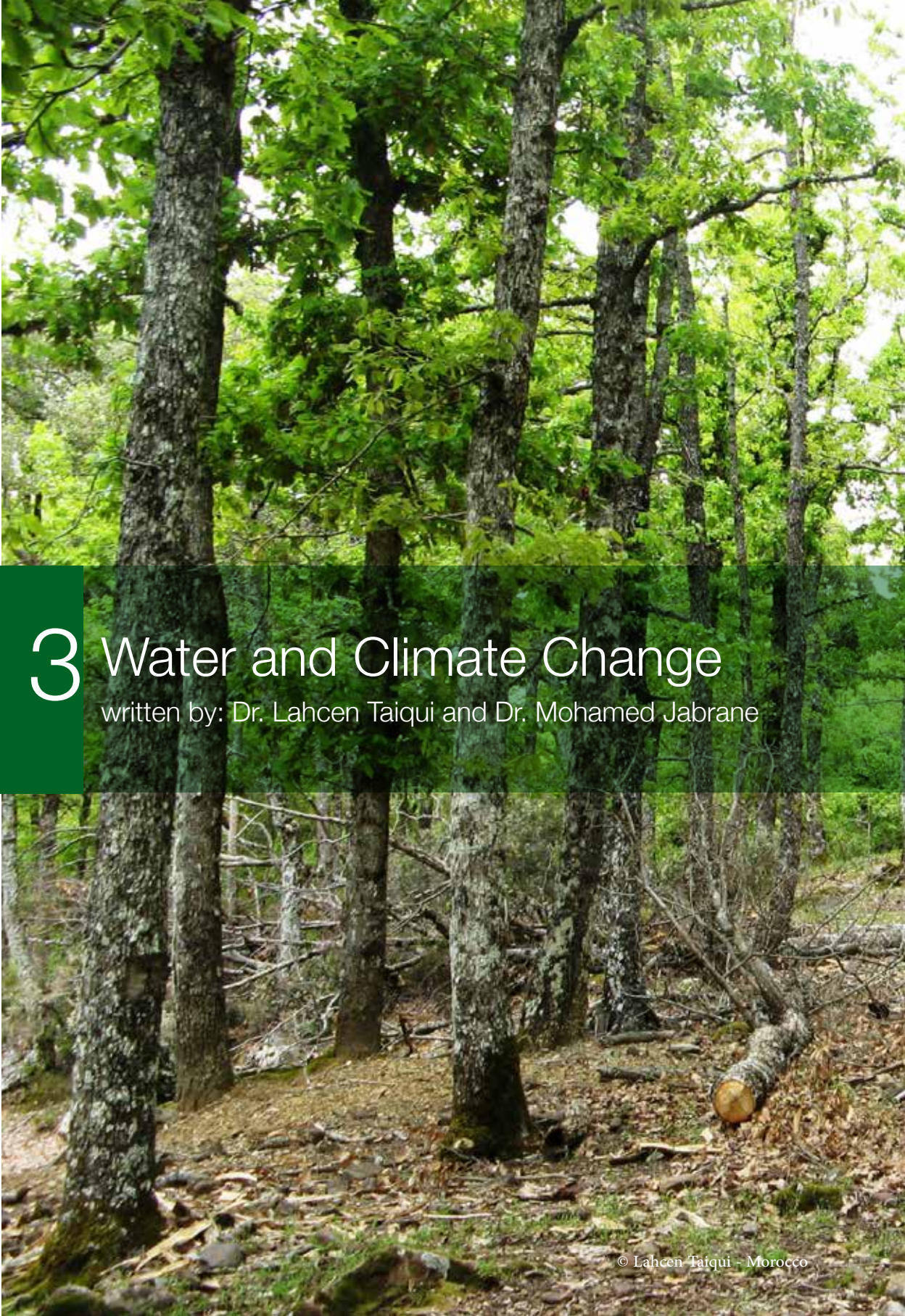

3 Water and Climate Change

written by: Dr. Lahcen Taiqui and Dr. Mohamed Jabrane

3. Water and Climate Change

Local Water Governance and Climate Change Adaptation and Mitigation are highly interactive. In most if not all situations governance of local water resources has to closely consider the requirements to adapt and mitigate the imminent impact of climate change. Implementing water resources management projects to face climate change is in most cases not effective when not considering modalities for local water governance. Where in the preceding Chapter the emphasis has been on governance, this chapter will more directly focus on climate change adaptation and mitigation. Nevertheless, the cases described make clear that local governance measures are important, as empowerment, participatory planning and social organization of direct water users area prerequisite to operate and sustain integrated water resources management (IWRM).

The first section of this Chapter shortly introduces the IUCN ROWA project on Social, Ecological and Agricultural Resilience in the Face of Climate Change (SEARCH) that was implemented in different countries of the MENA region. The second section illustrates processes and findings of the SEARCH project in the Tangier-Tetouan mountains of Morocco, while short case studies on Ground Water Contracts in different river basins in Morocco complement this Chapter. All cases deal with the necessary adaptation to climate change in view of degrading ecosystems and hydrological flows and hence rural livelihoods.

3.1 SEARCH

The SEARCH project, facilitated by IUCN ROWA, has been launched in 2013. It has demonstrated how climate resilience can be built in practice using IWRM to strengthen diversity in livelihoods and nature, ensure well-functioning watersheds, provide robust ecosystem services, increase self-organization through good governance, and promote learning. Demonstration projects were implemented between 2011 and 2013 in five countries of the MENA region, namely Jordan, Palestine, Lebanon, Egypt and Morocco. Where all five projects had a focus on building resilience, they obviously have given attention also to local water governance (Jordan and Palestine), the water, food and climate change nexus (Egypt) and to developing innovative technologies (Palestine). This Chapter will share the experience SEARCH developed in Morocco (Section 3.2), Jordan and Lebanon (here below), while sections in other chapters will stress the inevitable links between climate change adaptation and the other thematic areas of the R-KNOW work.

Box 3.1. Climate Change Resilience in the Zarqa River Basin, Jordan

In the increasingly polluted Zarqa River Basin, best practices for the sustainability of interventions included making information accessible to end-users from the onset and establishment of a local committee to lead the proposed approaches. After analysis of various sectors impacted by climate change, SEARCH drew up adaptation as well as implementation plans for each of the three demonstration communities to match the four main categories of resilience. The main goal of the interventions targeting “diversity” was to ensure that communities had various sources of income that are adaptive to climate change. “Self-organization” goals were mainly focused on maintaining community participation in building resilience. “Learning” worked to ensure that the community had the necessary skills to face climate change as well as efficient ways to keep updated on new climate change information. This pilot project was led by the Arab Women Organization (AWO) and was highly relevant for gender mainstreaming because it empowered communities including women through educating them about climate change and its impacts while providing them with tools to adapt and build resilience in the face of global climate change.

In Palestine, SEARCH worked with local communities in a watershed to improve conjunctive use of both ground and surface water, in order to improve the agricultural sector, by building possible scenarios for resolving problems and finding ways to help the local community to face climate change and advocate their adaptive management rights. This case study undertaken by PHG and UAWC is dealt with in detail in Chapter 5 on Sustainable and Innovative Technologies in the case study on the Marj Sanour Watershed.

In Egypt, in poverty-stricken governorates of Beni Suef and Minia along the Nile, best practices for the sustainability of the interventions included establishing farmer field schools and optimizing water usage were developed. The case study on Ehnasia District in the Nile Valley, led by CEDARE and CEOSS, is dealt with in detail in Chapter 4 on the Water, Food and Energy Nexus.

Box 3.2. Climate Change Resilience in Upper Akkar Watershed, Lebanon

Here SEARCH implemented activities that were undertaken by SPNL and MADA in Lebanon. This has established a hub for awareness and ecotourism, developed a public garden as a tool for forest conservation and community development, and identified three priority pilot projects for implementation. These pilots were: (1) rehabilitation of water tanks for sustainable agricultural purposes; (2) women economic empowerment in the same village; and (3) promotion of alternative income-generating activities to upgrade livelihoods.

In the marginalized Upper Akkar Watershed, best practices for the sustainability of climate change interventions included simple tools that are employed at the community level. The pilot project led by the Society for Protection of Nature in Lebanon (SPNL) was deemed highly relevant because communities were able to easily learn about the concepts of climate change resilience and adaptation and acquire the knowledge required to cope with and address the adverse impacts of other external changes through involvement in decision-making that integrates social, ecological and agricultural considerations.

3.2 Resilience to Climate Change in Morocco

Mountain Ecosystems in the Tangier-Tetouan Region, Morocco

Short Description of the Catchment Area

The Kingdom of Morocco is a constitutional monarchy with an elected parliament. It is bordered by the Mediterranean to the north, Algeria and Mauretania to the east, Mauretania to the south and the Atlantic Ocean to the west. The total landmass of Morocco is approximately 710,850 km^2 located between two climatic zones: the Mediterranean climate in the north and the Sahara climate in the south. Population is estimated to be 34 million, distributed between several urban centres and rural areas. The principal geographic features of Morocco include: a large extension in latitude, an important seafront, and extended high altitude mountainous areas, with peaks culminating to more than 4,000m in the Atlas mountain ranges, constituting a water reservoir for the country. This setting has a considerable impact on water resources,

agricultural production and vegetation cover of the country. Water resources, characterized by spatial and temporal scarcity and irregularity, are under increasing pressures from population explosion, expansion of irrigated agriculture and urban, industrial and tourism development activities (UNFCCC, 2001). Limited economic activities, lack of social services, weak infrastructure and top-down governmental approach to decision-making are among the most important factors affecting development in Morocco.

Before the 20th century, social ecosystems in Northern Morocco were largely self-sufficient agro-forest systems. Studies of landscape change and dynamics indicate that there are historical shifts from diversified agro-forest systems to overexploitation of resources (Taiqui & Cantarino, 1997; Taiqui, 2005). The resultant agricultural social ecosystem is quite vulnerable to environmental degradation, but expanding regardless of poor soil quality and inadequate agricultural conditions and without consideration to climate change and risks of increased intensity and magnitude of extreme meteorological events. Climate change is in addition to local environmental pressures, quickening desertification on the whole national territory[1].

Oued el Kebir Watershed

Oued el Kebir Watershed is located in the mountainous area of Tangier-Tetouan Region (Upper Martil Watershed, NW Morocco). Historically populated by Jbala tribes, the Tangier-Tetouan Region has about 3 million inhabitants and a surface area of 1,258km^2. Three types of landscapes can be distinguished in this region: the coastal and urbanized areas, the Atlantic plains and hill areas and the higher mountainous areas.

This case study is situated in the mountain areas and was selected as a pilot area for encompassing several common features with other mountainous landscapes in North Africa (Rif and Middle Atlas in Morocco, Tell in Algeria, Kroumirie in Tunisia).

Figure 5. Traditional Landscape of Tayenza Village in Oued El Kebir Watershed

[1] http://www.4c.ma/medias/MCCP - Moroccan Climate Change Policy.pdf.

The current population of Oued El Kebir Watershed is estimated at about 14,342 inhabitants[2], with a density of 64 inhabitants/km². Average rate of illiteracy in this area was estimated to be 66.1% in 2004 with no more than 1.2% of population with graduate level of education. Mean poverty rate (expenditure per capita below 320 Euros/year) was 31% compared to 14.2% at the national level in 2004 while mean rate of vulnerability to poverty (expenditure per capita between 320 and 476 Euros/year) was 21.4% compared to 15.9% at the national level in 2008. The human development index (HDI) (based on rate of child mortality, level of education and expenditure per capita per year) is mainly below 0.50 and social development index (access to water, electricity and roads) is between 0.15 and 0.45.

Rural municipalities are the basic decentralized entities constituted by an elected council responsible of local democratic management. Each rural municipality has a president elected by the political majority of the council. They constitute with other rural and urban municipalities a provincial council. Until the new constitution of 2011, however, decentralization of executive power to these local authorities was still minimal. With the new constitution municipalities are being empowered and the regional level strengthened with an elected government and more competencies. For each rural municipality, a communal development plan (PCD) is developed, through a participatory approach, for a period of six years. Introducing climate change considerations within the PCD in territorial planning is being promoted by different institutions (besides the SEARCH project), including a framework for mainstreaming environment into PCDs currently proposed by a project of UNDP in Morocco.

Climate Change in Morocco

Drought and precipitation scarcity are expected to reduce surface and subterranean water resources availability by 10-15% in 2020. Floods were recurrent in the last two decades with more intensity in North Morocco. Compared to other areas of the south and east of Mediterranean region, the climate of NW Morocco is more influenced by the Atlantic Ocean and dominated by humid and sub-humid Mediterranean bioclimatic conditions. Spatial variability of such climatic conditions is also evident due to the physiographic heterogeneity of this mountainous area, in comparison with the monotonous arid landscapes dominating the South and East of the Mediterranean. However, statistical downscaling results indicate a trend of annual temperature increase of 1.5°C by 2050. At the opposite, with an optimistic scenario, annual precipitation shows a trend to diminution by 70mm in 2050.

Participatory Approaches to Planning

Initial Steps

To develop and pilot a climate resilience framework in Morocco based on joint learning, participatory planning, capacity building and testing in demonstration sites, the Abdelmalek Essaadi University (UAE), Talasemtane Association for the Environment and Development (ATED), and IUCN-Med engaged in a partnership to work in the Oued el Kebir Watershed, focusing on building the skills and knowledge of local communities as well as other stakeholders necessary to be better prepared to face potential climatic change hazards. Through mobilizing different stakeholders and coordinating between them, the project team adopted a charter that specified modes of participatory work. It is based on effective communication, collective work as well

[2] Data from Communal Development Plans of Rural Municipalities.

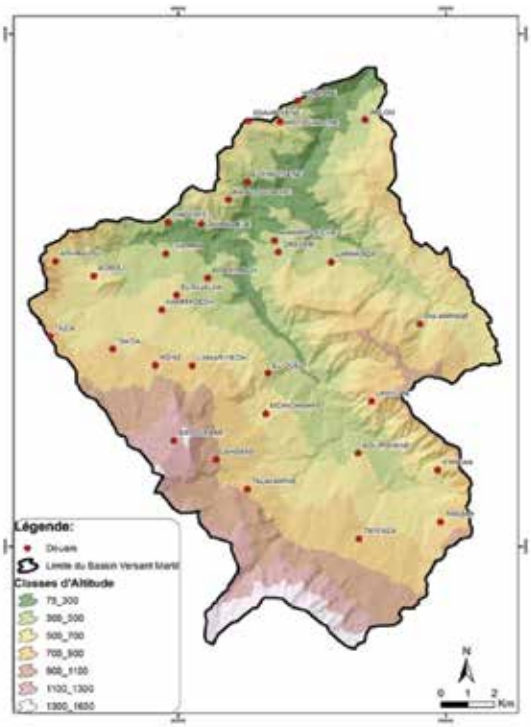

Figure 6. Map of Oued el Kebir Watershed Area

as design, planning, implementation, evaluation of activities and project documentation. This included enabling them to develop a realistic vision of the future and hence better anticipate climate change. To achieve this, SEARCH conducted a vulnerability assessment with the participation of local inhabitants, the representatives of the six rural communes surrounding the basin and relevant governmental agencies. The appraisal confirmed that resilience of the watershed and local communities is low and that they are exposed to harsh weather fluctuations. Livelihoods in the watershed rely almost exclusively on natural resources that are climate-sensitive and easily damaged if not eroded. With this initial work the representatives of the six local communities and other key stakeholders developed a shared vision for 2020 as provided below.

A resilient climate change vision for Oued el Kebir Watershed

"Improved living conditions of the population by building and improving the infrastructure (roads, electricity, water…) and providing access to basic social services and various economic activities."

The Further Planning and Empowerment Process

Through participatory planning, different scenarios were elaborated that stress the need to diversify sources of income, give added value to agricultural and forest products, adopt rainwater harvesting technologies and prevent soil erosion and landslides. Among the participatory approaches utilized where:

1. Consultation among stakeholders and other parties for exchange of information about different aspects related to the project. This consultation also included a gender sensitive survey with local communities to investigate preferences about agricultural activities for income generation.

2. Participation through meetings with local communities and watershed and steering committees. Main results were a joint assessment of vulnerability, a shared vision for resilience, prioritization of adaptive measures and implementation of pilot actions.

3. Partnership engagement encompassing a range of public agencies and local governance institutions and characterized by a high level of local involvement offering gender-sensitive training to inhabitants.

4. Self-mobilization by which local communities were encouraged to adopt adaptive actions by their own means or using their improved capacities acquired through the SEARCH project (associations formed, links with other stakeholders established, possibilities of funding covered …).

Box 3.3. Methodologies and tools used

1. PRA (Participatory Rural Appraisal) by country team and local communities.
2. RAAKS (Rapid Appraisal of Agricultural Knowledge Systems) for stakeholder analysis by country team.
3. Problem tree building.
4. CRiSTAL (Community-based Risk Screening Tool –Adaptation and Livelihoods) used with local communities.
5. CVCA (Climate Vulnerability and Capacity Analysis) used with watershed committee and with local communities.
6. Scenario building with watershed committees and local communities.
7. DEXIRA (Resilience Assessment) a qualitative model specifically developed by SEARCH in Morocco.

Technological Innovation and Achievements

Stakeholder/process results achieved by this participatory approach can be summarized in the following four points:

1. New processes of facilitation and leadership have been introduced that allowed to work closely together with key stakeholders and local communities, CBOs, municipalities and others. Technical and management capacities of key stakeholders were built through action-research, taking into consideration local priorities and national policies.
   They were able to apply appropriate tools for assessing climate change risks and vulnerability of local communities and identify ways to cope with such risks and vulnerability as well as the necessary institutional change processes. Agents of development represented in the country team and committees (from ministries and public institutions) have become more susceptible to local communities' taking ownership of, and accountability for, the management of ecosystems.

2. The participatory approach adopted at all steps of the process has led to the above results. At community and watershed levels, a particular outcome is the proposal of Planning Resilient Communal Development. At national level, an important outcome is participation in the process of developing the Territorial Climate Plan and contribution to the creation of the centre of competence on climate change in Morocco.

3. In the participatory process one association of farmers and two women groups have been established, and one agricultural women cooperative empowered. At the same time cooperation between local organizations has been strengthened.

4. Two pilot projects were implemented in the target area for later replication in similar land scapes: 1) introduction of a household rainwater harvesting technique adapted to fit rough slopes and sub-humid areas of deforested agro-systems experiencing water shortage during summer; and 2) launching an aromatic plants cultivation project in a region known for its overexploited natural resources and where aromatic plant cultivation is not practiced.

5. Resilience components that have changed were "diversity" (from very low to medium) mainly because of a slight increase of income sources, "capital and innovation" (from low to medium) due to the introduction of a rainwater harvesting technique and improvement of available technical experience and "self-organization" (from low to medium) at local and intermediate levels. As for "overall resilience," it has shifted from 'very low' to 'low'.

6. Sharing valuable information and knowledge at all levels. Structured attention was stimulated to document the methodologies and learning processes. The new insights, opportunities, lessons learnt and obstacles overcome were also captured for publication.

Box 3.4. Tangible outputs in the watershed that have led to changes in the components of the resilience framework are:

1. Increased government contribution (through funds by Morocco Green Plan).
2. Increased income sources (enhanced fruit trees and aromatic herbs plantation).
3. Elaboration of a toolkit to integrate climate change and land use planning in municipal development plans.
4. Partial improvement of domestic water supply (domestic rainwater harvesting).
5. Increased technical experience (through training) in planting aromatic herbs and in constructing rainwater harvesting systems.
7. DEXIRA (Resilience Assessment) a qualitative model specifically developed by SEARCH in Morocco.

Lessons Learnt

One of the main strengths of the project was the "technical team" that gathered the main stakeholders to actively participate in day to day decisions at a technical level. For this particular case the involvement was assured by:

1) the institutions' involvement from the beginning to ensure synergic priorities and real decision-making and 2) two level participation, at directive level (regional directors) and at technical level (technical team itself and appointed focal points for the project).

The technical team has constituted a real platform for joint learning between stakeholders and was very efficient in conducting the process internally and in the field, including facilitation of workshops and meetings with local communities and other stakeholders at different subnational

levels. Nevertheless, its role in institutionalizing SEARCH approaches for resilience has been limited. At municipality level, approaches for resilience assessment were largely appreciated, pilot actions were monitored by local authorities and there was a clear expression of interest in piloting "resilient municipal development plans" proposed by SEARCH. Important progress has been made to disseminate and upscale experiences and outputs of the project. Furthermore, at regional level, capacity building as a core SEARCH outcome and advocacy messages were capitalized so as to meet other national initiatives, allowing Tangier Region to be selected to coordinate, jointly with Marrakech Region, an ambitious project dedicated to the creation of a centre of expertise on climate change.

3.3 Ground Water Contracts in Morocco

At the South of High Atlas, between Mediterranean and Sahara climate, the coastal valley of Souss-Massa accounts for 18% of agriculture's contribution to Morocco's GDP. This important socio-economic value is provided by citrus and off-season vegetables production and exports, and mainly based on groundwater abstraction. After 34 years of overexploitation (1970-2003), the groundwater level fell 24 meters. The situation will probably be severely aggravated by climate change.

Indeed, the water capital in the Souss-Massa basin is actually estimated at 447 m^3/capita/year in 2010, and would pass in 2080 to 192 m^3/capita/year according to the optimistic scenario, or 123 m^3/capita/year by pessimistic scenario[3]. The overall balance of water shows a deficit of -167 million m^3 in 2007 and would reach -175 million m^3 in 2030, in the absence of adaptation measures to climate change. To address this vulnerability, the Master Plan of Integrated Management of Water Resources (PDAIRE) of Souss-Massa basin is considering to reverse this trend between 2012 and 2030 (see Box 3.5 about Basin Agencies in Morocco).

Box 3.5. Hydraulic Basin Agencies in Morocco

Hydraulic Basin Agency is a public institution with legal personality and financial autonomy. There are 9 Hydraulic Basin Agencies in Morocco. Within their area of action, they are responsible of planning, management, conservation, evaluation and monitoring of water resources, as well as prevention of the effects of extreme weather events including floods and droughts. Each Basin Agency has to develop and implement the master plan of integrated management of water resources and local water management plans in an integrated way and control water use, in particular, by establishing water supplies programs for different users. Basin Agencies deliver permits and concessions for use of public hydraulic domain and provide financial contribution and technical assistance to stakeholders for the development of mobilization techniques, rational use and protection of water resources. Hydraulic Basin Agency is administered by a board chaired by the government authority responsible for water. Two-thirds of the Board consists of government representatives (relevant government authorities, public institutions responsible for production of drinking water, hydropower and irrigation) and one third of the representatives of local governments, chambers of agriculture, industry and craft, associations of water users, and representative of Basin Advisory Council (abstracted from the draft of new water law of 2016).

[3] Third National Communication to CNUCC. http://www.4c.ma/mediatheque/docutheque/troisieme-communication-nationale-du-ma- roc-la-convention-cadre-de-nations

A diversified set of adaptation measures related both to offer and water demand is actually under implementation. It includes:

* mobilization of surface water,
* artificial recharge,
* desalination of sea water,
* safeguarding the hydraulic heritage,
* remediation and reuse of treated waste water,
* desalination of brackish water,
* rainwater harvesting, and
* water saving in all uses.

These measures would increase water supply from 901 million m^3 in 2007 to 1071 million m^3 in 2030, which would move from deficit to surplus since 2017-2018, with a surplus of about 100 mm^3 per year between 2025 and 2030 (Fig. 7). This is a good policy example of adaptation to climate change that can reverse the vulnerability situation of the Souss-Massa basin. However, the successful implementation of these measures depends on their integration into local, national and regional projects of sustainable development and resilience. Reaching sustainable development and resilience is a process encompassing different complex issues related to continuous learning by adaptive management, development of sustainable technologies, food-water-energy nexus, and (local) governance. In particular, the development of a political, regulatory and cultural environment conducive to good governance is crucial.

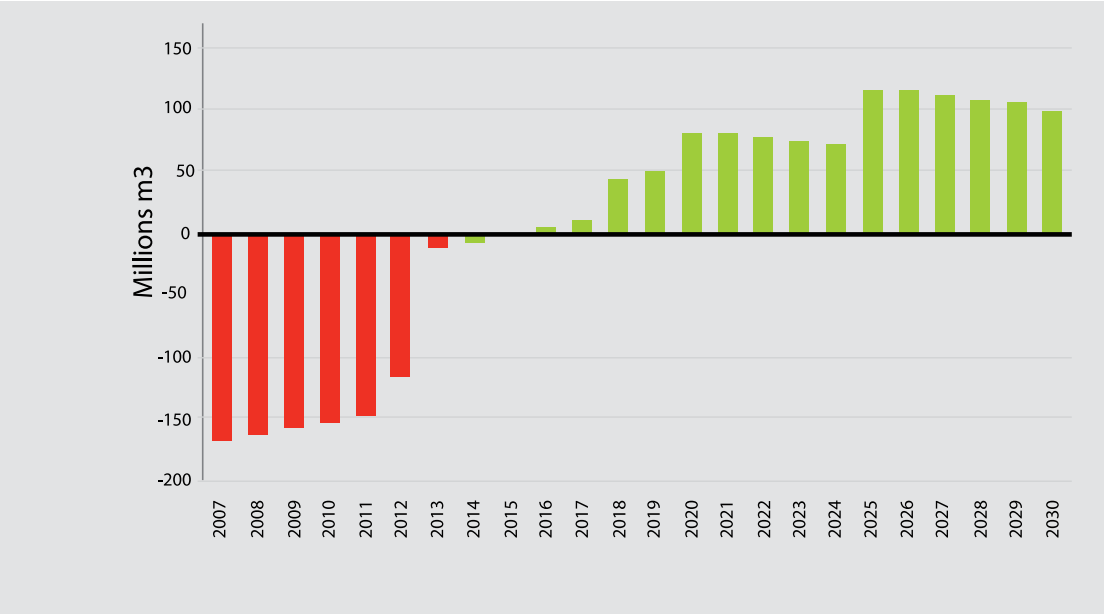

Figure 7. Planned Changes of Water Balance in Souss-Massa Region (PDAIRE Souss-Massa basin, 2013).

At governance level, Souss-Massa offers an innovative experience of a water coalition for inspiration and learning. The story begins in 2005 when the Souss-Massa Basin Agency decided to close some illegal wells. 90% of the wells were in fact not formally licensed. The farmer associations and other representatives protested the decision and organized a march in Agadir. The Regional Council and the Wali (Governor) consequently decided to defer the forced closures and initiate a negotiated solution instead: regularization of the wells and development of water saving techniques through a subsidy. The negotiation took almost a year in order to define all the rights and obligations of the many farmers and different institutions involved.

What resuted was the 'Ground Water Contract', namely 'a compact negotiated between a coalition of stakeholders in order to achieve shared policy goals about groundwater management'. In practice, legitimacy was given to the Souss Basin Agency to fight illegal withdrawals of groundwater and limit extension of irrigated acreage while securing the rights of the farmers thus making them partners in law enforcement instead of enemies.

This framework agreement for the protection and sustainable management of water resources in the Souss-Massa-Draa Region of Morocco was reached in 2006 among 24 institutions representing public interest, the private sector and civil society. Some of the arrangements in the agreement included extending drip irrigation to all farms and creating a network of meteorological stations to collect key data for assessing crop needs on a daily basis; mobilising a multi-institution network of agricultural researchers to join efforts on themes proposed by the farmers; initiating a large regional project on the use of desalinised sea water for irrigation; and promoting local crops such as argan, date palm and saffron. In 2007, a Public–Private Partnership (PPP) was also launched for the protection and sustainable management of the El Guerdan aquifer in the same Souss region. The State contributes 48%, the water operator 44% and the farmers 8% of the investment. The objectives of the PPP are to save 76 million m^3 of groundwater, reduce pumping costs by 50%, ensure localised irrigation on 10,000 hectares, and increase sales of citrus fruits thus securing 11,000 jobs.

The GWC is the most recent and innovative solution implemented in Morocco against groundwater depletion. The GWC represents an important solution that strives to place water management at the heart of policy responses to groundwater resources depletion and degradation. It seeks to gather the various actors in the water community and promote an integrated policy on groundwater management and climate change. The lessons learnt from this experience teach us that success for reaching this type of agreement depend on the involvement of political institutions at the local level (municipalities, regional governments) and on facilitation by and catalytic capacity of water management agencies.

The success of contract process was immediately captured by the Ministry of Water and integrated in National Strategy of Water in order to its replication at national level. After concertation with ministries of Interior and Agriculture, the Ministry of Water launched a National Programme for groundwater resources protection to negotiate and implement GWC in all major aquifers of Morocco that are either overexploited or in a deficit with water demand. The goal is to keep groundwater aside as a strategic reserve for drinking and industrial water, while avoiding undermining the most vulnerable farms. This should be achieved by improving knowledge about groundwater resources, strengthening the responsibilities of the basin agencies in the management of groundwater, the involvement of all stakeholders for a more rational and sustainable management and replenishment of strategic aquifers.

The National Programme is to develop a unified and concerted aquifer contracting process at central and basin levels with key ministries. It includes the establishment of a steering committee chaired by the Wali / governor for monitoring general guidelines of the contract and arbitration, and a monitoring committee chaired by a representative appointed by the Wali / governor for the implementation of action programs and regular monitoring.

In this context, the Loukkos Basin Agency decided in 2014 to initiate a process of GWC of R'mel aquifer located in Northern Morocco. This process of participatory planning in the R'mel aquifer has been chosen by the R-KNOW node in Morocco to further test and develop the SEARCH framework and methodology for social-ecological resilience. Due to some constraints in the process, the planning cycle is still at the assessment stage. These constraints are mainly related to lack of binding regulations, low level of commitment of some stakeholders and administrative procedures of technical studies. However, RKNOW's efforts to bring stakeholders to a common vision are very satisfactory. Similarly, participatory evaluation of the current situation of the R'mel aquifer showed an awareness and importance of commitment of elected local representatives in a contracting process incorporating their concerns for a healthy environment and sustainable development.

Several recommendations for improvement of GWC processes have been proposed in various meetings and national events. Among these, those of the National Workshop organized by the Ministry of Water in Skhirat (March 2014) suggest concrete improvements to various aspects of GWC: pre-requisite information and regulation, participatory management model, content contract and efficienc[4]. The National Seminar organized by R-KNOW in Tetouan in January 2015 adopted these recommendations and proposed[5]:

- reconciliation of groundwater contracts with local action plans;
- capacity building of stakeholders, particularly those of basin agencies;

[4]http://cmimarseille.org/sites/default/files/newsite/AFD/presenttions/Synth%C3%A8se%20atelier%20eaux%20souterraines%20-%235e%20GTE%20-%20mars%202014.pdf

[5] http://www.rknow.net/index.php/en/resources-en/meeting

- integration of surface water and aquifer management by the application of the approach basin;
- institutionalization of representative basins committees (parliament basin);
- introduction of a solidarity tax upstream - downstream and between watersheds and setting in place a system of payments for ecosystem services; and
- development and management of knowledge of climate change risks and impacts of socio-economic change on ground water resources.

To fill the legal gap and overcome the difficulties of its generalization, the GWC is now included in the draft of the new Water Law adopted by the Moroccan Government in 2016 and subject to the approval of Parliament. Adapted to the requirements of sustainable development and the combined effects of desertification and climate change, the goals of the current reform of the Water Law in Morocco is promoting governance in the water sector through the simplification of procedures and strengthening the legal framework for the use of rainwater and sewage, the establishment of a legal framework to desalinate seawater, strengthening the institutional framework and mechanisms of protection and preservation of water resources. In this new law, the GWC represents a new mode of groundwater governance based on participation, involvement and empowerment of stakeholders.


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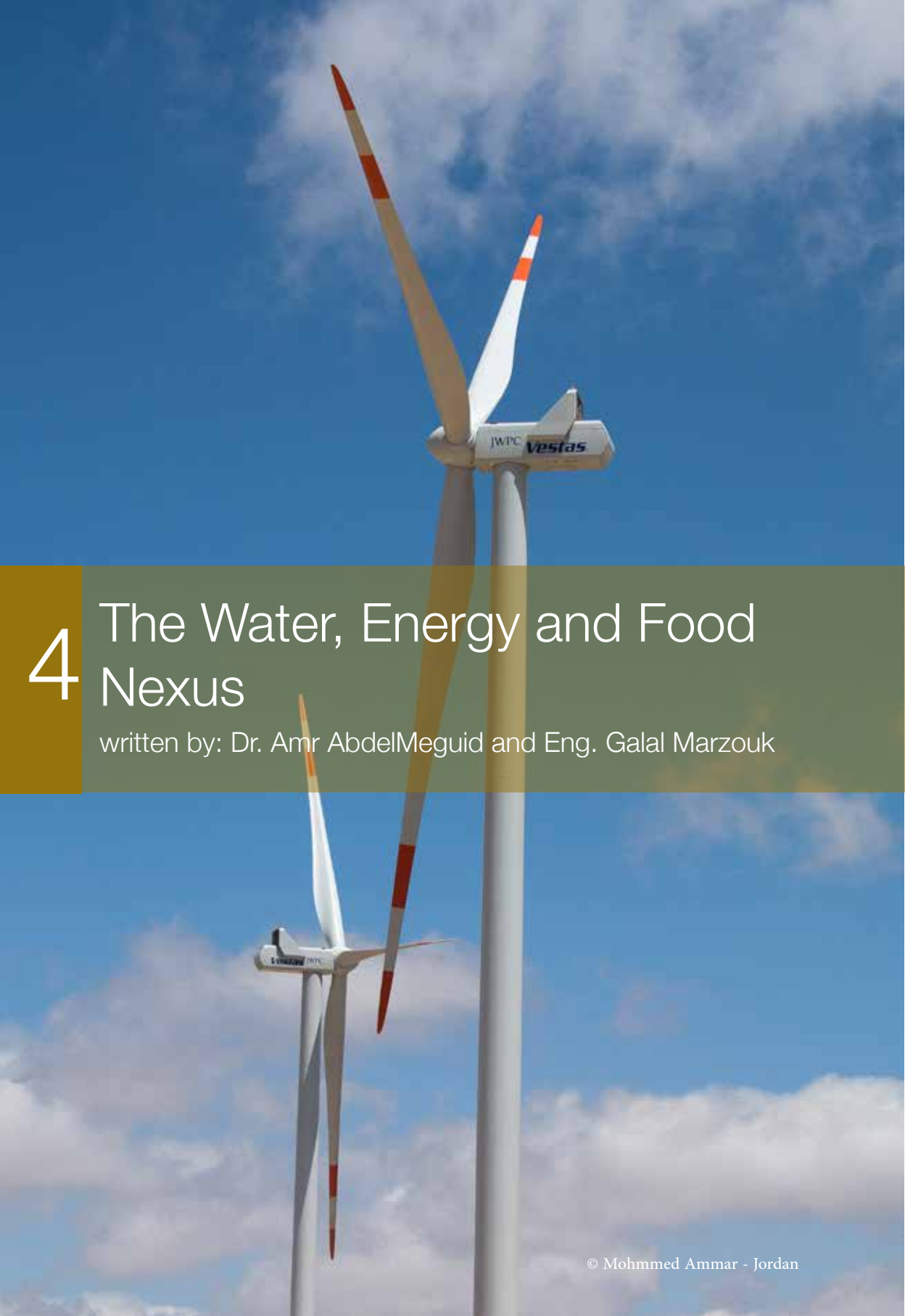

4 The Water, Energy and Food Nexus

written by: Dr. Amr AbdelMeguid and Eng. Galal Marzouk

4.The Water, Energy and Food Nexus

4.1. The Water, Energy and Food Security Nexus Approach

In the development arena new attention is given to the integration of different sectors and sub-sectors in more holistic approaches to development. Water and energy and agricultural use are all key elements in the Nile Valley agro-ecosystems. Their interaction is increasingly influenced by climate change phenomena and also here it is increasingly recognized that local governance and participatory planning and decision-making with local actors of water and ecosystems is a must. This Chapter will articulate how these aspects can come together in a Water, Energy, Food and Climate Change Nexus and can strengthen IWRM approaches in a river system as the Nile.

Introduction to a WEF Nexus Framework

The Water, Energy and Food security (WEF) Nexus framework aims to understand how each of these three sectors relates to the other two, how synergies and complementarities among them can be enhanced and hence how these sectors can be developed in a more holistic way. Such understanding can then be used to make policy decisions promoting poverty reduction and sustainable development. The interrelatedness among the three sectors should not be considered a hindrance but an opportunity to tackle development issues with a multi-sectoral integrated approach.

Also in the Arab Region coordination between water, energy and food security sectors offers important space for improvement. Where Egypt relies on the Nile River for 60% of its water supply and more than 80% of total water supply is used for agriculture, it still imports wheat and other basic food items. At the same time Egypt's long history of subsidizing energy is an important factor to be taken into account, given its impact across sectors and overall development. A reform of the subsidy strategy is developed to reduce gradually the subsidies while keepi ng the subsidies to the lower income category.

One cannot miss the meeting ground (nexus) of water, energy and food. Their inter-connectedness is not only of today but has been important since ages and certainly in the social ecological system of the Nile Valley at work since ancient Pharaonic times. For example, agriculture needs energy and water whereas the latter can be used as an energy source in food production. In other cases, links between the sectors are more discrete, like that of biofuel production and food security (Bizikova et al., 2013). Also, advances in one sector may lead to degradation of others. Inefficient use of water in agriculture can lead to excessive energy consumption to withdraw groundwater, which may later lead to food insecurity.

The nexus approach reaches beyond -acquiring or applying- technological advances; it requires cooperation across ministries, various levels of government and international collaboration. A nexus approach is in essence a new call for emphasizing integrated development approaches that link local and policy levels. In fact, reliable and effective governance –encouraging participatory development and local level engagement including stakeholder involvement, monitoring and evaluation of community responses - is critical to a nexus approach so as to ensure that priorities of those targeted/affected by policies are being met. The fight for poverty eradication, as again prioritized by the Sustainable Development Goals adopted in 2015 will continue to become ever more urgent, given that urbanization and climate change will add significant pressure on water, energy and food security sectors. Egypt is no exception to that.

A framework for a WEF nexus approach implies working within three fields of management, i) governance, ii) financial instruments, iii) environmental assessment. As for the governance domain, it entails sector coordination, stakeholder dialogue for concerted actions, community participation, and strong institutional setup. The financial instruments include incentives for private sector investment in renewable energy production, and to subsidize services, prices of agricultural inputs like fertilizers, and improving export and import strategies. Environmental assessment is mandatory to assess the impacts of policies on natural resources, ecosystems, impacts of climate change, valuation of ecosystem services, and vulnerabilities and resilience of specific socio-ecosystems. The coordination of these three fields of management would support policy and decision-making and planning processes within a WEF nexus and will highlight the tradeoffs that may be necessary. Connecting the three fields requires capacity building as a prerequisite at both institutional and human levels.

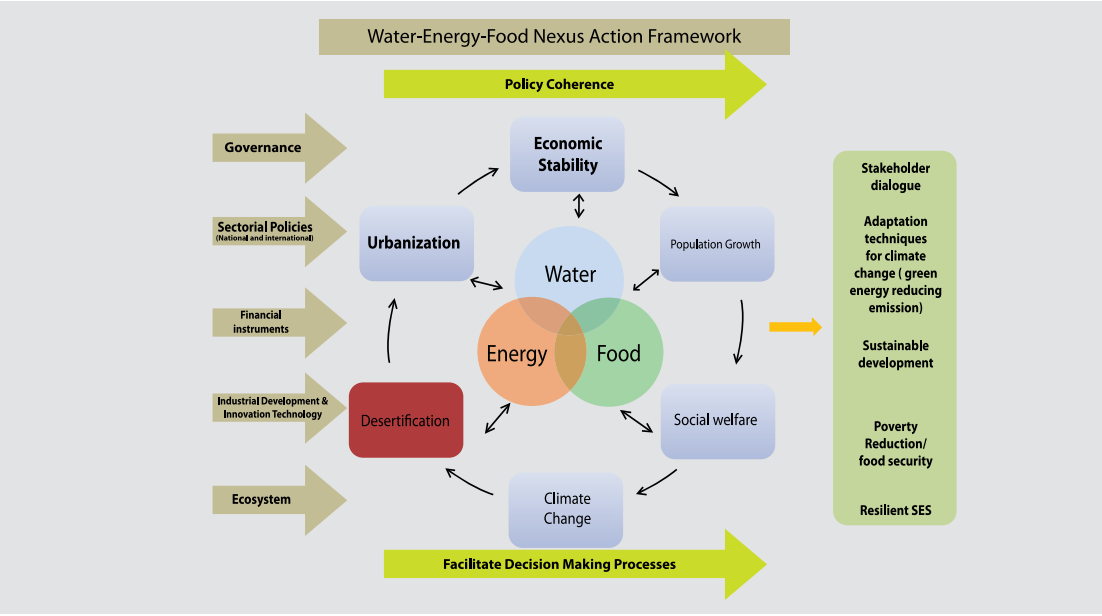

Figure 8. Water-Energy-Food Nexus Action Framework

WEF Nexus and its Opportunities in Egypt

The interdependencies of the water, energy and food security sectors are vital to the development of Egypt and as a matter of fact of the Arab region as a whole. Approaching these sectors with a nexus lens in Egypt can provide a strong example of how a nexus approach can be used in the greater Arab region to address national and regional issues. However, only a small number of individual development projects have utilized the nexus approach to bring sustainability to small parts of Egypt, and large-scale policy changes will be needed for Egypt to make substantial progress in these three sectors.

Egypt receives 55.5 billion cubic meters (bcm) each year from the water flow of the Nile River (Attia, 2009). More than 80% of this water is used for agriculture with current agriculture water demand at 57.8 bcm and expected to increase as population grows. Egyptian farmers

use over 1.8 million tons of fertilizer a year and a portion of that ends up in the Nile River and groundwater as long as proper buffers and practices are not in place (Nour El-Din, 2013). Water demand is expected to increase by 20% by 2050 and by 2025 water use per capita is expected to be 600 m^3, doubling from the current rate of 300m^3 (Ministry of Water Resources and Irrigation, 2014; Abdel Kader & Abdel Rassoul, 2010; "Water and Agriculture in Egypt," 2011). Domestic water use is 7% of total consumption but this is expected to increase as population grows (Abdel Kader & Abdel Rassoul, 2010). The Ministry of Water Resources and Irrigation has created a 2050 Water Strategy including plans to reduce water losses in the Upper Nile, address water pollution and promote stakeholder engagement (Nour El Din, 2013).

Figure 9. Landscape of the Nile Valley, Egypt

Industry, transportation services and residential use are the top three consumers of energy, making up over 70% of total final consumption ("Egypt: Balances for 2011," n.d). Egypt has spent almost $100 billion over the last decade on energy subsidies that make up over a fifth of Egypt's annual budget (Associated Press [AP], 2014; Castel, 2012). The national government endorsed energy subsidies reforms in June 2014, with the Egypt's National Energy Efficiency Action Plan calling for a target energy efficiency of 5% by 2015. However currently there are limited incentives for households and industries to demonstrate smart use of energy (Regional Center for Renewable Energy and Energy Efficiency [RCREEE], 2013a).

The avian influenza epidemic of 2005, the fuel and financial crisis of 2007, and macroeconomic instability since the 2011 revolution have all made Egypt's population vulnerable to food insecurity (Breisinger, Al-Riffai, & Ecker, 2013). In 2011, the World Food Programme estimated that 17.2% of Egypt's population is food insecure and 35% of people have poor dietary diversity (WFP, 2013b). 86% of vulnerable households in Egypt claim their monthly income is insufficient for their needs in terms of calorie intake (WFP, 2013a). Egypt has established food subsidies as part of its safety net to protect the poor; however, a study by the International Food Policy Research Institute (IFPRI) found that 17% of the most vulnerable households are still excluded from the national ration system (Breisinger et al., 2013). Recent reforms by the government, such as the introduction of a smart card system to keep track of purchases and the elimination of subsidies for bakers, have attempted to address these problems. The goal of these reforms is to prevent waste from the over purchasing of wheat (Ahmed, 2014). The reforms are also meant to improve the targeting of social programs.

In short, there is large scope to improve water and energy efficiencies and the effectiveness of food security programmes. Egypt's Sustainable Agriculture Development Strategy towards 2030 emphasizes enhancing water use efficiency in irrigated agriculture and has introduced the nexus approach for decreasing water use in agriculture. Among others, the strategy includes

stabilizing rice cultivation at 1.2 million feddan, introducing irrigation on the "old" agriculture lands in the Nile Valley and the rehabilitation of irrigation systems in reclaimed "new" lands in the desert areas. These proposed changes are estimated to save Egypt 13.5 bcm of water per year ("Water and Agriculture in Egypt", 2011).

Hydropower currently makes up 83% of installed renewable energy capacity in Egypt and the government has plans to increase total installed renewable energy capacity from its actual 11% to 20% (RCREEE, 2013b). Additionally, the government's desire to diversify its renewable energy supply by increasing wind and solar energy may encourage more environmentally-friendly approaches to energy production and use notably in the agricultural/food security sector.

Lastly, water is not only a potential source for energy generation, but haulage of water, by abstraction from ground water or by "horizontal" pumping in irrigation/drainage systems, can be made more energy efficient by using renewable energy sources as wind and solar energy. This is essential for preserving the Nile Valley agro-ecosystems and the services they provide. Indeed investments in renewable energy may trigger financial flows from the private sector towards the water and agricultural sub-sectors that could be charged though licences and taxes. Income from such charges could then be used for investments in more efficient water and agricultural use and conservation of ecosystems. These energy charges could also be considered as payments for the services the water/land ecosystems in the Nile Valley provide to society (food, maintenance of hydrological flows and decreased pressure on ground water resources).

Such potential financial flows and payments for ecosystem services need to be coupled with agricultural policies that reduce the production of water-intensive crops and consider virtual water trades as a conservation tool for the water and energy sectors (Gelil, El-Ashry, & Saab, 2013). In the Arab Region studies estimate the effects of climate change to lead to a 3° to 7° C temperature increase by the end of the century which could reduce groundwater supplies by 40% as well as reduce crop productivity and agriculture yields ("Food security and nutrition in the Arab region: key challenges and policy options," 2012). In Egypt, rice productivity may decrease by 11%, barley by 18%, corn by 19% and wheat by 18% in 2030.

The WEF Nexus and its Opportunities in the Wider Arab Region

Interactions between water, energy and food security sectors are obviously important across the wider Arab region. Currently, the region's population is above 358 million and expected to upsurge 50% by 2050 ("Food security and nutrition in the Arab region: key challenges and policy options," 2012). Hence, poverty, resources depletion and degradation are increasingly distressing the region. Despite containing 43% of the world's oil reserves and huge potential for renewable energy, 35 million people in the region remain without access to modern energy services, mainly electricity (Gelil, El-Ashry, & Saab, 2013). The region possesses only 1.4% of the world's freshwater sources, making it the world's most water scarce region in absolute and relative terms (Siddiqi & Anadon, 2011; Sadik, 2013). Despite the fact that the Arab Region is the world's largest importer of wheat, the recent economic instability has left its population even more vulnerable to food insecurity (World Bank, 2009), with a quarter of the children suffering from stunting and food insecurity. Accordingly, utilizing a nexus approach in the Arab Region has the potential to benefit all three sectors and reduce poverty through the improvement of livelihoods and job creation (Gelil, El-Ashry, & Saab, 2013).

The opportunities for utilizing a nexus approach are particularly apparent when observing the interactions between the **water** and **energy** sectors. It is estimated that the water cycle, from abstraction to post-use treatment , may use up to 15% of national electricity consumption in most Arab countries (Gelil, El-Ashry, & Saab, 2013; Siddiqi & Anadon, 2011). In Libya, 14% of total fuel consumption is used for groundwater pumping (Siddiqi & Anadon, 2011). Besides, the Arab Region is currently home to 50% of the world's desalination capacity (Mofor, 2013; Moawad, 2011). By 2050, energy demand for desalination will increase with improved desalination technology and the Arab region must consider how it will power these plants in the future. These links become even more critical when the impact of these changes in water and energy use will have on agriculture and food systems.

The benefits of conservation are also tremendous for the Arab Region. Reducing energy losses to only 10%, from the current 19.4%, would save the region $5.5 billion. Furthermore, transitioning to compact fluorescent lighting could reduce carbon emissions by 2.56% (Gelil, El-Ashry, & Saab, 2013). Expanding the water cycle could also bring immense benefits to the region. Libya, Kuwait and Qatar could meet all of their industrial water needs by recycling 25% of their annual wastewater (Siddiqi & Anadon, 2011).

Apart from these more global regional impacts a nexus approach to water, energy and food security has already important impacts at more local levels, as is illustrated by two short cases for Qatar and Oman (Boxes 4.1. and 4.2.) developed by a joint initiative of IUCN and the International Water Association (IWA). The objective was to explore how competing demands on water resources across the water, energy and food sectors could be addressed with private sector companies by providing multi-sectoral solutions through infrastructure and other means, including new technologies and investments in ecosystem services.

Box 4.1. ***The Sahara Forest Project in Qatar***

Current models of production and single-focus technology solutions neglect and/or waste many resources that can be utilised to achieve restorative growth. The Sahara Forest Project (SFP) developed an innovative solution designed to utilise what we have enough of (deserts, saltwater and CO_2) to produce what we need more of (food, water, and clean energy). This was done by combining already existing and proven environmental technological components, including saltwater-cooled greenhouses, solar power technologies and technologies for desert re-vegetation around a saltwater infrastructure. The synergies arising from integrating the technologies improve the performance and economics of the system compared to those of the individual components. The simple core of the concept is an infrastructure for bringing saltwater inland in low-lying desert areas. Through this infrastructure the SFP aims to:

(i) generate electricity from solar power more efficiently,

(ii) operate energy and water-efficient saltwater-cooled greenhouses for growing high value crops in the desert,

(iii) produce freshwater for irrigation or drinking, safely managing brine and harvesting useful components from the resulting salt,

(iv) grow biomass for energy purposes without competing with food cultivation, and

(v) re-vegetate desert lands.

From 2009 the concept has been developed with the aim to implement and up-scale it in Qatar and Jordan. A fully functional SFP Pilot Facility was built in Qatar through a partnership between Yara International ASA, Qatar Fertilizer Company (Qafco) and the SFP. The pilot facility involved a multi-purpose built greenhouse. At one end of the greenhouse seawater is run down a surface whilst fans blow desert air over it. The evaporation of the seawater results in cool and humid air within the greenhouse, thus lowering the temperature. The condensation of moist air, using pipes cooled with the seawater, results in a fresh water source for irrigation. The energy produced for the operation of the greenhouse is generated within a concentrated solar power plant within which solar energy is used to create steam and drive turbines. By bringing together local and international entrepreneurs, scientists, business and other key players in green innovation, the SFP Test and Demonstration Centre will be a platform for research, innovation and training for sustainable solutions to the food, water and energy challenges.

Additional activities will include using the seawater for cultivating algae and halophytes for biomass, and salt extracting by evaporation. The successful operation of technologies identified by SFP indicates the effectiveness and competitiveness of the concept in challenging conditions. Findings prove that there are significant comparative advantages using saltwater for the integration of food production, re-vegetation and renewable processes.

Box 4.2. Use of wetlands like reed beds for water treatment

In the oil and gas industry, understanding and improving water use is increasingly important as global freshwater supplies come under increased pressure and demand for energy increases. Considering this, Shell is looking into new approaches and advanced technologies to help reduce the amount of water needed and used for its operations. One aspect being worked on is the recycling of produced wastewater that contains small amounts of salts and oil. Traditionally this water is disposed of by injection into deep or shallow disposal wells.

However, several organizations are looking into use of wetlands like reed beds for water treatment . Reed beds have proven to be capable of efficiently, and cost effectively, handling the treatment of the produced wastewater from the Nimr oil fields in Oman. This treatment has double benefits:

- The ability to reuse produced wastewater: In parts of Oman, fresh water is extremely scarce, but more than five barrels of produced wastewater are brought to surface for every barrel of oil and this water has to be disposed of;
- Reduction or elimination of the power consumption and CO_2 emissions associated with the operation of equipment for deep well disposal.

In Oman, Petroleum Development Oman (PDO, Shell's share 34%) created the world's biggest commercial reed-bed water-treatment plant: a 360 hectare facility treating 95,000 m^3 of contaminated water every day. The reed bed facility is a four-tier gravity-based wetland design. Gravity pulls the water downhill, the reeds act as filters, removing oil from the water. The oil is eaten by microbes that naturally feed on hydrocarbons underground. Locally grown *Phragmites Australis* plants are used for the purification of produced water.

The facility layout includes a pipeline, which enters the treatment plant system and leads to an oil/water separator. The water is then distributed into a wetland facility where it is channelled through the wetland terraces by gravity feed. Finally, evaporation ponds are used to recover the salt while the biomass is currently planned to be land filled. Alternative uses of the water and biomass that could offer a variety of social and environmental benefits are being explored. For example, the biomass as an energy source or the treated water made available for use by local communities.

Participatory Nexus Approaches and Knowledge Sharing

The nexus approach is at its core a management and governance tool that uses collaboration and coordination to attain holistic success across sectors. One of its main components is the use of participatory approaches in stakeholder-led planning and decision-making. Participatory planning is not a linear process; rather it is an iterative cycle with internal feedbacks that ensure the constant participation of each stakeholder in the planning and implementation process. Thus, stakeholder engagement is crucial to ensure that projects and policies are not only environmentally sustainable but also socially acceptable and supported by those groups affected and directly involved in implementation of activities on the ground.

At the end of this Chapter another more elaborate case study illustrates a participatory planning and decision-making process with multi-level stakeholders for the nexus of water, food security and climate change resilience in Ehnasia Water District in the Nile Valley agro-ecosystems of Beni Suef Governorate in Egypt.

Recommendations for Policy and Practice

Egypt is at a critical point in its development, especially after the political turmoil of recent years. Its perspectives for development will only be further complicated by population growth, urbanization and climate change. The nexus approach presents an opportunity for Egypt to make strides in water, energy and food security -without comprising its natural or social environment- through effective governance adopting inclusive approaches, ultimately aiming at economic growth.

Based on the analysis of potential and case studies for a WEF nexus approach, the following recommendations are put forth to promote sustainable development of each of the nexus' three sectors in Egypt:

1. Development of a national grant award for development projects utilizing the nexus approach to promote coordination and collaboration across sectors.
2. Creation of a national nexus knowledge platform to enable information sharing.

3. Implementation of a nexus steering committee comprised of policymakers, researchers and civic organizations to oversee development projects in these three sectors.
4. Earmarking a portion of the expenses saved from reforming energy and bread subsidies for renewable energy, sustainable agriculture and water conservation projects.
5. Paying attention to extending the life cycle of food, water and energy by increasing energy efficiency and improved management of wastewater and organic waste.

4.2. Climate Change Resilience in the Ehnasia Water District, Egypt

The Nile Valley, Egypt

Description of Ehnasia Water District in the Nile Valley

Ehnasia Water District is situated in Beni Suef Governorate, south of Cairo and forms part of the complex irrigation/drainage water management systems that have evolved over 5,000 years in the Nile Valley. For about two centuries (2242- 2452) BC, Ehnasia was the capital of Egypt during the era of the ninth and tenth dynasties. Agriculture is the most significant economic activity in the governorate. Most of the population, about 2.59 million, work in agriculture (according to the estimated census of 2012).

Ehnasia District is 17 km south west of Beni Suef city. It is bounded by Naser district from the north, Somosta District from the south, Beni Suef District from the east and Fayoum desert from the west. The lands in this governorate extend alongside Nile shores for about 155km. The Nile in this area is about 9km width in average. Most of the agricultural lands are located west of the Nile. The western part of the district is close to the desert areas. Some of these desert areas (6000 feddan) were reclaimed through the Youth Project. This area is a natural border that separates the governorates of Beni Suef and Fayoum.

Figure 10. Landscape of Ehnasia Water District in the Nile Valley, Egypt

With a total area of the district of 1007.55 sq km (218.87 sq km being inhabited), Ehnasia is one of the biggest agricultural districts in Beni Suef Governorate. It has about 17% of the agricultural land in Beni Suef. The District has five local village units namely (El Awanaa, El Nowiera, Brawa, Nena and Qay). Such local village units oversee 36 mother villages and 153 hamlets. The population of Ehnasia district is about 320,000 (according to the estimated census of 2012). Most of the population, almost 80%, work in agriculture. Ehnasia district depends mainly on two sources of water; the Youssefi and Ibrahimia sub canals. The biggest sub canal is El Sultani canal. The total area of the cultivated land is about 44,800 feddan in addition to the reclaimed area. These areas are irrigated by the side canals originating directly from Youssefi and Ibrahimia canals using the triple shifts system. Reuse of drainage water is practiced to supplement irrigation water in lands at the tail ends of the canals. The most significant crops are cotton, wheat, onion and tomatoes. Natural mineral resources include limestone, gypsum, gravel and sands.

Figure 11. Map of Ehnasia Water District

The most significant challenges that face irrigation and water management in Ehnasia are: limited water resources, increasing water demand that exceeds the water supply in summer, continuous increase in population, negative behavior and practices of upstream farmers, reclamation of desert lands unaccounted for in national plans, and very low annual rainfall rate. Moreover, as mentioned in the report of the local development plan that was made for Ehnasia District by the Social Fund for Development with participation of local community representatives mismanagement of solid waste, high level of subsurface water in agricultural land, and increased soil salinity were identified as additional problems.

Climate change resilience is a multi-sector and multi-actor concern and hence different stakeholders at different levels need to be involved. The key categories of stakeholders relevant in Ehnasia Distirict for this are:

- Governmental institutions: research centers, Directorate of Agriculture, affiliated bodies, agriculture district; affiliated districts and units, the Public Directorate of Irrigation, the General Directorate of Drainage, Irrigation and Drainage Directorate, and the Bank of Development and Agriculture.
- Non-governmental organizations: CSOs, CDAs, WUAs, agricultural associations and cooperatives; and the media.
- Private organizations: shops selling pesticides, seeds and fertilizers; pesticides› factories,
- Individuals: male and female farmers; landowners and tenants.

Participatory planning and decision processes (2007–2013)

In view of above concerns and issues, the Centre for Environment and Development for the Arab Region and Europe (CEDARE) and the Coptic Evangelical Organization for Social Services (CEOSS) partnered to implement a pilot project to explore how climate change resilience can be strengthened within the framework of sustainable water resources management (IUCN SEARCH[1] Programme 2010-2013). This pilot project built on an in-depth participatory and stakeholder-led planning and decision making process to come to better and sustainable resources management of the Nile water flow in the District (IUCN REWARD[2] Programme 2007-2010).

The following methodologies were adopted in all project phases. First, capacity building in using tools to engage in participatory stakeholder planning and tools to adapt to climate change. Second, engage in participatory planning and management. Last, documentation of methodologies and learning processes, as well as exchanging valuable information and knowledge at all levels. The project adopted a participatory stakeholder planning approach as described at the end of Chapter 1: Visioning, Assessing, Strategizing, Planning, Implementing & Reflecting.

Visioning

In an early stage of the process the following provisional vision was agreed upon by the different stakeholders for Ehnasia district:

> *Increased agricultural productivity in order to improve the livelihoods of farmers in Ehnasia, while seeking a clean environment.*

In order to achieve such a vision problems associated with climate change were further analyzed and categorized by farmers, local communities, and agricultural associations together with staff of agricultural extension and irrigation sectors. This resulted in four main categories of problems: (1) **poor crop production and low farmers income** (lack of awareness on climate change, weak marketing of some crops, high prices of seeds and production requirements, weak usage of agricultural machinery and old drainage network); (2) **increase in plant diseases and pests** (emergence of new pests because of rising temperatures, shortening of pests' life cycle, increase of fungal and pests diseases, rise of humidity rate that may cause infection of pest and fungal diseases and hence may lead to increased use of pesticides); (3) **poor solid waste management practices** (lack of farmers awareness on waste management and recycling methods, farmers' believe that recycling needs certain skills that they don't possess, weak marketing of products and by-products of recycling and poor waste management by governmental institutions); and (4) **summer irrigation problems** (lack of irrigation water in some areas at the tail ends of canals in summer and non-commitment to the cultivation cycle, affecting water distribution).

Assessing:

In cooperation with most of the relevant stakeholders mentioned above, an assessment was conducted using the RIDA framework. This simple framework looks to water in terms of Resources, Infrastructure, Demand and Access. It helps in developing a structure to collect and analyze relevant information. Tools such as PRA, Problem Tree and CRISTAL were also used in analyzing the factors influencing agricultural production. Basic sources of data were the

[1] SEARCH stands for "Social, Ecological and Agricultural Resilience in the Face of Climate Change" and was a three year regional project funded by the EU and implemented in five countries; namely Lebanon, Egypt, Jordan, Palestine, and Morocco, aiming to develop and pilot a resilience framework for adaptation to climate change in watershed ecosystems.

[2] REWARD (Regional Water Resources and Dryland) Programme is a multi-donor/multi project implemented by the IUCN ROWA Office since 2007.

knowledge of representatives of governmental and non-governmental organizations, meetings held with farmers, PRAs that were conducted in a participatory way, and outcomes of a Problem Trees Analysis to better understand cause-effect relationships. Secondary sources of data were governmental data published by stakeholders such as Ministries of Environment, Agriculture, Water Resources and Irrigation, researchers, studies, articles and opinions on the field of climate change in addition to the meetings held in the areas where the project is implemented.

As part of the assessment a reflection was made on vulnerability and adaptive capacity of local people and the study area (the social ecosystem) to climate change. Vulnerability and adaptive capacity concepts as defined by (Bates et al., 2008) are discussed in Chapter 1. A vulnerability assessment of the study area was made displaying the affected areas/sectors, events, exposure and degree of sensitivity of the system, and the degree of adaptive capacity of the area. Moreover, a vulnerability map for Ehnasia was developed by CEDARE, displaying the Human Development Index (HDI) for Beni Suef -as one of the indicators for vulnerability- and identifying the areas most vulnerable to climate change. The map proved that Ehnasia District is among the lowest HDI ranked areas, indicating that it is very vulnerable socially, economically, health wise to climate change as well as to food security.

The discussion on adaptive capacity covered the current practices of local inhabitants to handle climate change impacts, whether these practices are enough and effective and how they could be strengthened to cope with climate change and how obstacles faced in implementing these adaptive practices can be tackled. To this effect, a number of tools were used to measure the adaptive capacity of the study area, potential impacts of climate change, consequent problems, sectors that have less ability to face impacts of climate change as well as identifying the places most vulnerable to such hazards. As a result, a matrix of such adaptive capacity was developed displaying the risk, impacts, coping measures, effectiveness and suggested adaptation measure. Challenges like lack of funding, lack of climate change awareness, limited water resources, fragmentation of land ownership (majority of farmers own less than 2 feddans) and lack of coordination between stakeholders and farmers were further discussed.

Strategizing:

As described at the end of Chapter 1, in this phase of the planning cycle stakeholders decide on a number of strategies (broad sets of potential practical actions) to achieve their vision – under a range of possible future scenarios. The result of this is a selected number of priority activities that form part of an agreed strategy, and high quality plans to implement them, while ensuring sufficient funding for their implementation.

Meetings at different levels were held in order to develop strategies in Ehnasia that address climate change resilience for water resource management and agricultural production. Scenario building followed a three-phase approach: scenario development, scenario finalization, and strategy development under different scenarios. This basically entails developing the final vision, identifying factors affecting the vision, and finally categorizing these factors with respect to their importance and uncertainty. The most influential factors and challenges to achieve the vision for Ehanisia in the eight possible scenarios are: availability of funds, exposure to climate change impacts, awareness of climate change issues and improvement of agricultural productivity. However, only three -of the eight potential- scenarios were relevant for Ehnasia. Hence various resilience strategies were developed under these three scenarios aiming at reducing vulnerability and increasing adaptive capacity of the area.

Scenario building and strategy development for Ehnasia District has indeed given high importance to strengthening resilience. Resilience, as explained in Chapter 1, is defined by (Bates et al., 2008) as: "The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organization, and the capacity to adapt to stress and change." Strengthening resilience of the social-ecosystem of Ehnasia District to enable achieving the vision for the District will be realized through reduction of vulnerability and increasing adaptive capacity of the area. The four main strategies for strengthening resilience were therefore discussed under the anticipated scenarios. These four integrated resilience strategies are:

- **Enhancing diversity** of the economy, livelihoods and nature.
- **Promoting sustainable infrastructure and technology** that combine both engineered and 'natural infrastructure', as well as adaptable and sustainable technologies reducing vulnerabilities.
- Mobilizing self-organization: A critical characteristic of resilient, highly adaptive systems is self-organization of local communities and is implemented in practice through participatory governance and empowerment of people in adaptive institutions.
- **Facilitating learning:** Ensuring that individuals and institutions can use new skills and technologies needed to adapt and make better use of climate information and adaptation strategies.

With the further information acquired during scenario building and strategy development a more specific resilience-focused vision was developed for Ehnasia District by 2020. This vision is formulated as follows:

A climate change resilient vision for Ehnasia District:
A more competent and resilient community to cope with climate change, to decrease risks, and achieve optimal agricultural productivity in order to ensure appropriate income for the community and people working in the field of agriculture.

Proposed Innovative Approaches and/or Technologies

To achieve this vision suggested interventions include:

a) Ensure participation of farmers in water resources management and planning, while narrowing the gap between theory and farmer practice;

b) Raise awareness of farmers on climate change,

c) Implement aggregated crops system and Improving agricultural marketing;

d) Promoting a culture of water saving and nature conservation;

e) Safe disposal of solid and liquid wastes;

f) Supporting the maintenance of water-ways and use of sage as organic fertilizers to replace chemicals;

g) Enforcing environmental and irrigation law enforcement.

In order to explore practical ways to undertake some of these proposed interventions a number of pilot projects have been designed and decided upon:

Pilot Project 1: "Farmer field schools" in El-Masharka and Mayana villages in the field of awareness and climate change (intervention a and b)

This participatory farmer applied research model was tested under the name of "Specialized Farmers Field School" in 2012- 2013 by the SEARCH project in cooperation and coordination with the Agriculture Directorate of Beni Suef, aiming at raising awareness and adaptation to climate changes. Consequently, awareness increased in the field of adaptation to climate change, contributing to the adaptive capacity and hence resilience, socially, ecologically as well as agriculturally. Moreover, the knowledge level of the targeted groups increased by 25%.

Pilot Project 2: Plantation of tolerant and economic trees to maximize the use of water (intervention d)

Based upon the resilience strategy developed in Ehnasia to rationalize water consumption, a pilot project called "Cultivating Moringa Trees" was implemented. This type of tree is useful for adaptation to climate change, as its water consumption is very low and it can be cultivated on the sides of waterways, gardens, around houses and roads, while it has important fodder quality and other economic benefits as roots and leaves are sold at high prices. Awareness-raising sessions were held on the importance of this tree for community representatives. Accordingly, 500 seedlings and 1500 seeds were cultivated, nurtured and provided to farmers at a low price.

Lessons Learnt for Up-scaling

A National Policy Workshop was organized by the SEARCH project in Egypt to share results and illustrate how these results have been obtained with concerned stakeholders including Ministries of Water Resources and Irrigation, Agriculture, and Environment, the National Water Research Center, Environment and Climate Change Institute, Shores Protection Institute, Central Laboratory for Climate, CEOSS, Maiana Village Civil Society and CEDARE. The recommendations that came out from the workshop – can be categorized into four groups: **Participation**, **Dissemination, Thinking and Behavior Change and Policy**. As lessons learnt from other case studies, they will be further described and analyzed in Chapter 6.

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5 Innovative and Sustainable Water Technologies

written by: Dr. Ayman Rabi and Sayel Weshahi

5. Innovative and Sustainable Water Technologies

While empowerment and active involvement of local users and beneficiaries of water resources is a prerequisite to operate and sustain integrated water resources management (IWRM), there is also urgent need to explore how actually used water technologies can be innovated to make water resources management sustainable. This is all the more important in view of the imminent needs to adapt to processes of climate change and the erosion of ecosystems that provide the natural resource basis for use of water for agriculture. This Chapter will illustrate how such technological innovation could take place in one of the Palestinian watersheds as one outcome of a long process of social organization and participatory planning with stakeholders at both local and national levels. Hydrological flows from water run-off from the surrounding hills to recharge of aquifers from flood water form an important factor in preserving the agro-ecosystems in this very fertile but closed watershed. Good management of water resources and related ecosystems has indeed been enhanced by local water governance practice and social organization, also in view of a highly restrictive Israeli occupation measures that strongly affect access to water, compounded by possible climate change threats.

5.1 Marj Sanour Watershed Management, Palestine

Mountain Ecosystems in Palestine

Description of the Watershed

Marj Sanour is a small watershed of a valley in Jenin Governorate in the northern part of the West Bank in historic Palestine. The watershed covers about 59 km^2, with a valley floor of 16 km^2 (16,000 dunum) and is situated within the area of the North-Eastern Aquifer Basin (Jenin-Nablus Basin) and has a Mediterranean Climate (Weshahi et al., 2013). Much of the surrounding hills are planted with fruit orchards (26,241 dunum), dominantly olives, the most important cash crop in the country used for producing olive oil and other tree crops such as olives, grapes, figs, almonds and nuts. In addition rainfed crops are grown including grain and vegetables as wells as vegetables based on irrigated agriculture (16,640 dunum), while bee keeping and livestock are common in the watershed region (Weshahi et al., 2013).

Figure 12. Marj Sanour Watershed

Seven villages are situated in the watershed with a total population of 27,500. Landownership averages 13 dunum but can reach 250 dunum. Around 60% of farmers own less than 10 dunum and around 15% more than 20 dunum (Weshahi et al., 2013). Most farmers, apart from their own land, also rent land from others. Due to geological conditions, the valley has no surface water outlet, and as a result it is flooded almost every year, forming a lake of -in places- more than 4 meter deep. This water comes from surface run-off from the hills due to poor land management and water conservation. Rainfall (sometimes snow) can vary between 400 and 1200 mm with an average of 634 mm/year (Weshahi et al, 2013). In years of heavy rainfall the total amount of water standing in the valley can reach up to 10 million m³, while in very dry years flood volume is still about 1 million m³ (in the winter of 1991/1992 it reached an exceptional high volume of over 20 million m³) (Weshahi et al., 2013).

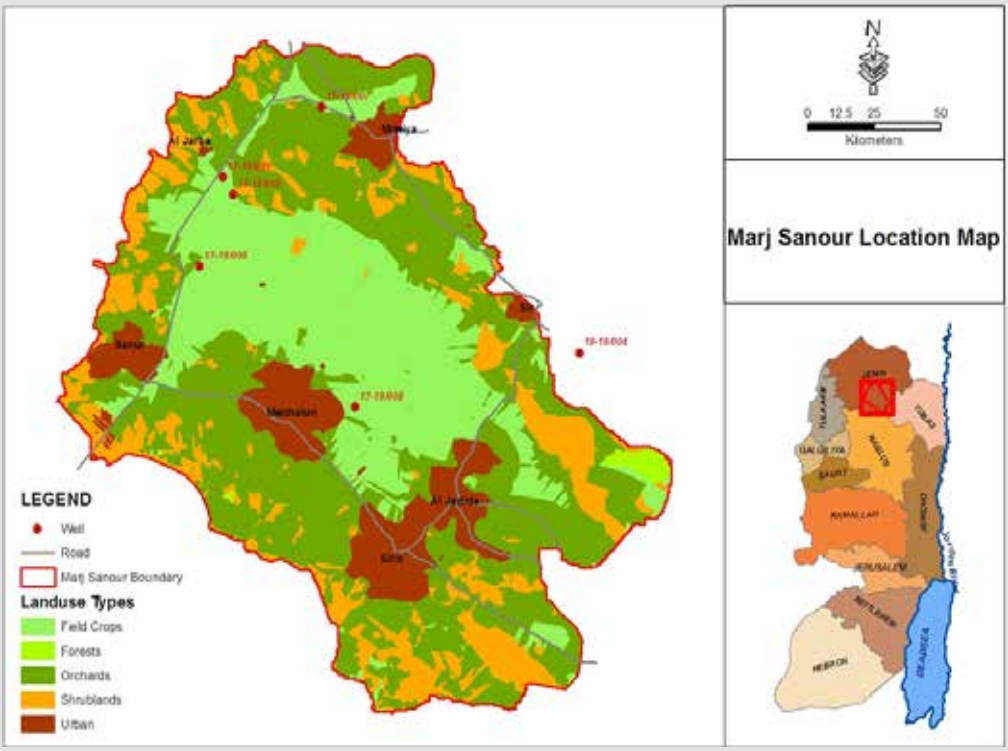

Figure 13. Marj Sanour Location and Land Use Map

Because the rainwater cannot penetrate the heavy nutrient-rich clay soils eroded from the hills in recent ancient times, it is not possible to be recharged entirely to the shallow Jenin aquifer (of Eocene formation with a water level depth of 100 to 140 m from ground surface) and most is lost to evaporation and cannot be used in the following dry season for irrigation when there is water scarcity. The flooded area is around 5,000 dunum (average between 1990 and 2007) with a peak of 9,000 dunum in 1991/1992 (Weshahi et al., 2013). Thus, farming is limited both by flooding and the lack of water (drought) in the dry season. To compensate for this lack of surface water, further pressure is placed on the shallow groundwater reservoir.

Indeed, in spite of the important but unreliable flood water, groundwater remains the main water source in Marj Sanour Watershed. While domestic water is mainly abstracted from deeper aquifers (notably from the Turonian-Upper Cenomanian Aquifer at more than 700 m depth) the shallow aquifer is mainly used for agricultural purposes. Abstraction of water from this shallow aquifer is mainly from around 50 irregular agricultural wells drilled in the area and estimated at 2.27 million m^3/year (Weshahi et al., 2013). Due to this over-pumping the water table of the shallow aquifer has dropped in the last 15 years by 80 meter or more than 5 meter/year. With still 20 meter depth of ground water left, it means that if no measures are taken there will be no water left in the aquifer in 4 to 5 years from now. As this drop in ground water levels has caused serious reductions in pumping from agricultural wells, farmers have been forced to seek alternatives to increase water availability to sustain agriculture in the area.

It is important to note also that the Marj Sanour (marj means meadow) is quite high positioned in the landscape and serves in fact as a "water tower" for the surrounding lower valleys, the aquifers underlying the marj feeding the wells in Qabatia to the north and springs and wells in Faria'a to the east.

Box 5.1. Real-time monitoring technology for water resources in Palestine (written by: Mr. Omar Zayed, PWA)

Groundwater is the main source of water in Palestine, but is under high stress of exploitation and contamination, for an important part due to severe access restrictions by Israeli Occupation Authorities. Widely observed effects are a decline in water tables as well as deterioration of groundwater quality. In many coastal areas, seawater intrusion or land subsidence is experienced.

Monitoring of an aquifer is of fundamental importance as a basis for groundwater resources management. Monitoring, data collection and analysis provide the information that enables rational management decisions on all kinds of groundwater resources and with regard to sustainability issues. At the same time, manual monitoring of groundwater levels using cable data loggers is a time and resource consuming activity. It often requires two or more people, can damage the equipment, and does not even guarantee data series that are continuous. "Diver" water level data loggers are the world's most widely used instruments for automatic measurement and registration of groundwater level, conductivity, temperature, and other parameters.

Water level loggers can be read and programmed onsite or linked to a telemetry system for complete offsite management. For these reasons, the Palestinian Water Authority has installed an automated retrieval of diver data. The new technology with automated reels for divers is significantly time and efforts saving. This provides online flow monitoring for 48 potable water wells through transmission of the flow data to a central control room in Ramallah.

In the future, wireless data measurement will be added to the well monitoring network so that no manual involvement for retrieval will be needed, with no chance for diver damage, and only one person will be required to do the readings, bringing the time needed for collection of data to much less than at present.

Programme Development Background (2003 – 2015)[1]

As described above, it was urgent for all concerned to understand the options for dealing with both drought and flooding, two main problems that were blocking development and to find watershed management solutions that held benefits for all stakeholders. A watershed development plan was developed between 2008 and 2010 with close involvement of the seven communities in the watershed and with support from PHG and UAWC in a project that formed part of IUCN's Regional Water Resources and Drylands (REWARD) Programme in the Middle East. The watershed plan should enhance sustainable use of surface water and improved agricultural development, while diminishing the pressure on the groundwater reserves. The development of the watershed management plan built on earlier participatory stakeholder-led water sector planning efforts in Maithaloun, the main community in the watershed, by the EU funded EMPOWERS project with CARE International, PHG and UAWC.

Application of the EMPOWERS Planning Cycle in Marj Sanour began in 2003 with an in-depth stakeholder analysis involving most relevant ministries – Palestine Water Authority (PWA), Ministry of Agriculture (MoA) and Ministry of Local Government (MLG) and Environmental Quality Authority (EQA) – at both governorate and national levels, water and land use groups and other community based organizations (CBOs), village and municipality councils, non-governmental organizations (NGOs) working in the area, and a Jenin-based university. The analysis looked at how these groups relate to the watershed in terms of their tasks, roles, interests and mandates. It also looked at information flows among them and their decision and coordination patterns.

Two platforms ensured participation of different local interest groups as well as the buy-in of the government institutions. An informal local stakeholder platform was set up for village council and civil society groups in the seven villages, NGOs working in the area, and officials at the governorate level. A national steering committee was also created involving community representatives, NGOs and national government agencies. Through the local platform, a participatory planning and decision-making process was used to work towards a vision for a long-term management plan for the Marj Sanour watershed. At the same time, and with the support of the national steering committee, a shared information-base of scientific and engineering data was developed as well as a decision support system for planning and testing different scenarios and strategies under which the vision for the watershed could be achieved. What is also important in the case of Marj Sanour that in this valley there is a special problem, the flooding, that cannot be solved at the individual or community level; this shared problem was an important reason for people and organizations to work together.

Following intensive discussions, seven villages decided to develop the Marj Sanour Watershed Association to coordinate and implement activities for all water and agriculture related activities, from drinking water supply and irrigation practices to soil and water conservation in the hilly parts of the watershed. The Watershed Association, formally registered with the government, now represents the villages in wider fora, where it can present proposals to the government agencies and the donor community, based on the conducted studies and results of the decision support system and the watershed development plan.

Further study has been done between 2011 and 2013 on climate change vulnerability and resilience in the water shed (Weshahi et al., 2013). Following IPCC (2007) parameters (Exposure, Sensitivity and Adaptive Capacity) the Marj Sanour watershed is categorized as highly vulnera-

[1] Adapted from case study in SPRING on ground water management (Laban, 2016)

ble to drought and flood. An in-depth stakeholder consultation has developed a shared vision to respond to such vulnerability. This vision is formulated as follows:

> *Rural livelihoods in Marj Sanour watershed area are rescued through demonstrating effective ecosystem/watershed management tool and improving conjunctive use of both ground and surface water in order to improve agricultural practices.*

To strengthen community and watershed resilience in terms of diversity, sustainable infrastructure and technology, self-organization and learning, a set of priority actions were developed, with the most important infrastructure/technology actions being in the domains of water harvesting, reclamation and rehabilitation of land and ground water recharge.

Resulting Main Technical Interventions Proposed

The Watershed Development Plan

The watershed development plan is the outcome of the above described multi-stakeholder participatory planning process and is endorsed by the MoA and PWA and the Marj Sanour Watershed Association that is registered with the Ministry of Interior. It has received interest from development and funding organizations, triggering around 1 million USD of S&W conservation and water infrastructure investments until now and another 3 million USD for new similar investments, mainly for recharging wells and water reservoirs in the valley floor, and soil and water conservation through land rehabilitation and land reclamation on the hill slopes.

Soil and Water Conservation in the Hills Surrounding the Valley

To solve the flooding problem and carry over water to the dry season, the stakeholder group –using the mutual planning and multi-criteria analysis- recommended several projects that focus on stopping floodwaters before they reach the valley by improving the terracing and water retention of soils in the hills and by building cisterns in the hills to collect and store water for supplementary irrigation of trees and crops on terraces as well as –thanks to restored terraces- to improve water retention and infiltration to the shallow aquifer. They also recommended building more cisterns in the valley to carry over water to the dry season. Thus through land management (rehabilitation and reclamation and water harvesting), the water can be more evenly distributed over time to benefit both the hill and valley dwellers as well as the ecosystems in the watershed, while relieving pressure on groundwater reserves. Land rehabilitation in the form of stone retaining walls for terraces and cisterns is costing in average around 700 USD/dunum, including a 25% contribution from the benefitting farmers (150 USD/dunum for about 30 meter retaining walls; and a cistern of 40 m^3 serving 3 dunums at a cost of 2,000 USD). Heavier works of land reclamation is costing around 1500 USD/dunum, the latter however resulting in more productive land (better soils/less stones, and more olive/almond trees that can be planted per dunum).

Artificial Recharge of Shallow Aquifers from Flood Water

To avoid water over-flooding the valley, strongly impeding agriculture on otherwise very rich soils, proposals have been developed to drill as a pilot two artificial water recharge wells that, after filtering the water from sediments and pollutants, bring excess water to the underlying shallow aquifer, now at around 140 meters deep.

The pilot demonstrates that artificial recharge is a very promising alternative that can contribute to enhancing ground water supplies. Groundwater recharge wells are suggested to be one of the most suitable techniques for the Marj Sanour area due to the following reasons:

a) Availability of floodwater in the area on an almost annual basis, as large parts of the Marj are submerged during a period of a few months;

b) Good storage potential within shallower aquifers, especially in view of receding ground water tables.

Figure 14. Filtration System - Gabions, Around an Artificial Recharge Well

The two pilot recharge wells were designed by the Palestinian Hydrology Group (PHG) and drilled under their technical supervision as an activity of the Land and Water Resources Management Project, implemented by UAWC and funded by the Netherlands. The main aim, as described above, is to assist in recovering the accelerated decline of groundwater levels, minimize the submerged agricultural area and on the long-term avoid lack of water for agriculture on the very rich soils of this valley. The two wells were drilled in the areas that would flood the most, and the recharging water now passes through a filtration system that was built for the purpose of cleaning it up from sediment as the main contaminant of concern. It is estimated that the shallow aquifer will be recharged with about 9,000 m^3/day by the two wells; this means around 300,000 m^3 on an annual basis for an average flooding period in different parts of the valley of about one month. The groundwater level is planned to be monitored through the agricultural wells in the surrounding area.

As part of the participatory planning and decision process described above, a workshop was conducted in the Marj Sanour municipality in 2014, in the presence of the Palestinian Water

Authority, Ministry of Agriculture of Palestine, PHG, the Union of Agricultural Work Committees (UAWC), farmers, Marj Sanour Watershed Association and well owners, to discuss the location of the two pilot artificial recharge wells. As stakeholders agreed, the Watershed Association supplied the land and is now managing the project with the support of all stakeholders.

The locations of the boreholes were chosen in the area of the Marj that is most exposed to flooding but that is away from the mainstreams to avoid strong runoff loaded with huge quantity of suspended materials.

Further studies have been made on risks of chemical and biological pollution to make sure that this water will not pollute the aquifer. Chemical pollution is assessed as being minimal and does not exceed other areas. Although studies on biological contamination are still underway, it is safe to say that, with the information available today, such contamination effects will be very little. Two recharge wells have been installed as a pilot at a cost of 60,000 USD each. As mentioned they are able to drain together 300,000 m^3 from the flooded valley that in years of heavy rain can contain around 10 million m^3. When 8 other recharge wells are installed, the resulting recharge of the aquifer could compensate the over abstraction for irrigation by the many irregular wells in the valley, now estimated at 2.27 million m^3/year. This would avoid a catastrophic situation that in 5 years time irrigated agriculture would not anymore be possible in this extremely fertile valley that can produce two to three crops a year. Moreover the recharged water will also benefit the springs and wells in nearby areas, such as in Faria'a and Qabatia. The installation of recharge wells is quite an innovation, unique in Palestine and even in the region. Staff of PHG is now requested to provide technical advice on similar interventions in Jordan, Iraq and Tunisia. Apart from the two pilot recharge wells also earth water ponds are constructed in the valley floor with a capacity of 25,000 m^3, for storage of flood water.

5.2. Renewable Energy & Water Pumping: Technology Innovation in the Bahareya Oasis, Egypt (written by: Dr. Amr Abdel Meguid, CEDARE)

Oasis Ecosystems in Egypt

This case study highlights the role of renewable energy in improving water governance, tackling climate change, and facilitating sustainable agricultural development for food production in Egypt and the MENA region at large. In the Bahareya Oasis of Egypt, a young Cairo-based private company 'KarmSolar', a solar technology provider, worked with local farmers at a technological innovation of solar water pumping for agricultural production.

In off-grid desert locations, ground water extraction is the primary stage of the agricultural process. To comprehensively tackle the water-energy-food nexus and climate change debate, energy needs must also be addressed in off-grid locations such as oasis where agriculture is an important basis for livelihoods. Food and other crop production begin here with the extraction of water from underground aquifer systems, for which high energy is needed.

KarmSolar is developing, testing and now operating in Bahareya Oasis High-Capacity Off-Grid Battery-Free Solar Water Pumping (SWP) systems that power high capacity submersible electric pumps with energy generated by a photovoltaic solar installation. The SWP system can be applied on the majority of pumps commonly used in the agricultural sector and, while upgrading the pumping system, will also allow the partial replacement of diesel generators. The SWP system allows

[2] http://karmsolar.com/pumping-irrigation/

stable pump operation at variable speeds, matching the changing available solar energy, therefore maximizing system efficiency due to low energy waste and maximum pump output. This is done through custom-design to adapt to the power needs of submersible pumps that can be easily scaled to meet changing energy demands, which in turn allows the drawing of water at increasing depths[2]. However, a Transfer Switch can be installed to utilize both solar and diesel energy sources, if a diesel generator is needed to extend pump operation hours at non solar peak times.

It is obvious that such technological innovations have direct social and economic effects on oasis farmers and other stakeholders within the agricultural sector, but also on the environment and its natural resources. The case study also demonstrates that renewable energy projects are not only possible with provision of grants and subsidies. This is especially important where subsidies have become unsustainable as these come at a steadily increasing cost and cannot easily be up-scaled beyond a pilot area.

Having taken the initiative on a private sector basis, it places innovative companies as Karm-Solar as an important actor in 1) reducing the cost of water supply (which is directly affected by energy costs incurred by running pumping systems), 2) limiting groundwater withdrawal rates, and 3) better administering aquifer and climate data (through the use of a Solar Management Interface (SMI)). Private investors however, require policies that provide space for or even catalyse approaches that can maximise commercial benefits. The case study also demonstrates that despite the initially perceived limited economic interest, the private sector is looking for new opportunities and in many emerging markets (ICA-IUCN-IWA, 2015). It can indeed be assumed that the private sector is more likely to understand an integrated supply chain than public silos, and could hence be more effective at analysing and subsequently resolving the challenges of developing approaches to integration of water, food and energy demands as has been described in the former Chapter on nexus approaches (Allan et al., 2015).

5.3 Desalination of Brackish Water for Agriculture – Marj Na'ajah, Palestine (written by Mr. Issam Nofal, MoA)

Oasis Ecosystems in the Jordan Valley, Palestine

The Jericho district in the Palestinian Jordan Valley suffers from the upsurge of salt water in the aquifers. The Jordan Valley is situated between 150 and 350 meter below sea level and has an arid climate. The Eastern Aquifer Basin, which is the main source of water supply for irrigation in the district, comprises a layer of saltwater covered with lenses of freshwater. The cropping pattern in the study region is mainly vegetables (93% of the total cultivated area of 111.3 hectares in the village). Wealthy Palestinian farmers and Israeli settlers, however, are shifting from growing vegetables to other high salinity resistant crops such as date palm. In order to cope with the shortage of suitable irrigation water and poor quality in terms of increasing salinity, the Ministry of Agriculture of Palestine has installed a desalination unit for low water quality agriculture at the well in Marj Na'ajah, about 40 km north to Jericho in the Northern part of the Jordan Valley. The total number of direct beneficiaries is around 40 farmers though the intervention could benefit around 200 more people indirectly. The desalinated water is mixed with brackish water from the aquifer wells and with this mixture a total area of around 300 dunum can be irrigated.

Figure 15. Map of Marj Na'ajah Area

Desalination is a water saving alternative to brackish water irrigation but its diffusion as a viable method of water treatment has been limited by high costs and concern about the lack of plant nutrients in desalinated water. Technological advances have made desalination an economically feasible solution for high-return agriculture, especially in arid regions where water cost may be excessive due to distance from, or depth to, the water supply. The desalination unit in Marj Na'ajah that works with reverse osmosis technology has an inlet capacity of 75 m^3/hr and an outlet capacity of 55 m^3/hr. Salinity at the inlet is 4500-5000 ppm and at the outlet only 200 ppm. Installation cost was 160,000 USD, including the desalination unit (100,000 USD) and the storage tanks, pumping units and brine line (60,000 USD).

By the end of the first agricultural season, an increase in crop productivity and crop quality was experienced by the farmers. As a result, the cropping pattern in the area has changed and new crops such as peas, beans, okra, and other salt-sensitive crops are now being cultivated successfully.

The Ministry of Agriculture was however concerned about the impact of using desalinated water on soil and plant productivity, especially in the absence of enough studies of these effects on the soil type of the area, i.e. clay loam saline soil. Two field studies were therefore commissioned to research the effects of irrigating heavy saline soil with pure desalinated water (TDS 200 ppm) compared with recommended blended desalinated water (TDS 750 ppm).

The studies would particularly focus on Soil Sodium Adsorption Ratio (SAR) at different depths, soil structure, and water movement in the saline soil profile; and investigate the effect of irrigating heavy saline soil with desalinated water and blended water on plant productivity and fruit quality. Tomato was selected for the field research for its long growing season (October to March) to give a better indication about the effect of irrigation on the plant productivity and soil prosperities. The Box below presents the main results of the two studies.

Box 5.2. Results of field studies

Effects on soil properties of irrigating heavy saline soils with desalinated water

- A clear increase of the Sodium Adsorption Ratio (SAR) especially in the upper 15 cm soil layer.
- A negative impact on soil structure in the surface layer (15 cm).
- An increase of horizontal water movement and a decrease of vertical water movement as compared with brackish water.

Effects of irrigating heavy saline soils with desalinated water on plant productivity and quality

- A decrease in macronutrient content (N, P, K, and Ca) of heavy saline soil with decreasing water salinity (the decrease ranges from 45-77% and was highest for Ca.).
- Desalinated water and raw saline water gave the lowest level of tomato crop production with only 12 kg, and 13 kg respectively.
- When tomato is grown in heavy saline soils this effect can be alleviated by blending desalinized irrigation water with brackish water.
- Irrigating heavy saline soil with raw saline water and blended water with TDS 750 ppm gave the best fruit quality results, while desalinated water gave the lowest fruit quality.

On the basis of the field study results it is recommended that Calcium and Magnesium should be added to the soil while blending desalinated with brackish water can be considered as a low cost strategy to increase Calcium and Magnesium content in the soil. Improving soil management practises to increase leaching of sodium salinity out of the root zone should nonetheless be encouraged as well as further studies of the amount of fertilizers needed under the different water salinity levels and of the long-term effects of desalinated water on the fertility of heavy saline soil and plant growth (by measurements over consecutive years of planting these soils with crops). Such studies should be done under direct supervision by the soil and irrigation experts to follow the farmers who are using desalinated water for irrigating their farms.

Social acceptance was also an important factor in the uptake of this practice. What helped with that was the short film produced in 2014 by the Ministry of Agriculture to show the reactions and feedback of the farmers about the effects of the desalination unit on their income.

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6 Lessons Learnt for Up-scaling

written by: Stefano Barchiesi and Dr. Peter Laban

6. Lessons Learnt for Up-scaling

The implementation of the projects that formed the basis for the case studies described in the preceding chapters, has created many new insights and lessons that could be replicated and used elsewhere. This Chapter will provide an extract of the experiences gained, new insights and lessons learnt that are –in the view of the authors of these case studies and the many staff involved in the related projects- important to share with others, so as to achieve sustainable water resource management in the dominantly water scarce watersheds and ecosystems of the Middle East and North Africa Region.

The experiences described in this Knowledge Book exemplify the potential for achieving impact at larger scales and over longer time periods. These justify the need to catalyse change at multiple levels and across inter-related, though frequently poorly coordinated, sectors. This is what it is called scaling-up or "institutionalisation" of verified best practices from demonstration and pilot projects.

6.1 Scaling-up Local Water Governance

The many case studies in this Knowledge Book have given importance to good local water governance and the need for participatory planning and management approaches, as these are considered fundamental for ownership and sustainability of local actions for water resource management. It is however important to recognize that such participatory approaches and local governance modalities form important elements of NEXUS approaches that seek better integration of often highly inter-linking sectors, such as the water, energy and agriculture/food production. To this it can be added the close relationships within such a nexus with actions to be undertaken to mitigate and to adapt to climate change impacts. As mentioned, most of the case studies here described contribute to meeting a number of important SDGs, as will be further elaborated below.

6.1.1 Assure Buy-in of Water Users

- Applying participatory approaches to involve and empower local stakeholders through Water User Associations requires process facilitation. It would start with a community needs assessment as well as analysis of local accountability for water resources and use. Using traditional communal resource management approaches such as "Hima" that often are integrated and holistic of nature is recommended also for local water resource management planning as it takes well into consideration social, economic and environmental factors.
- Assessing water availability, demand and perceived water use rights is a first step towards sound water management and exploring ways for reducing consumption per capita. This needs to be accompanied by promoting behavioural changes with regard to water in villages, so as to enable creating a common vision at the local village level and guidance for future replication at national level.
- All the case studies emphasize the importance of local team work and acting together among different stakeholders to deal with shared problems. Many problems that farmers faced in the past remained unresolved due to the individualistic approach and interests that guided most of the farmers/water users. In many of these cases the story of participation delivered win-win situations.

6.1.2 Raise Water users' Technical and Organizational Capacities

- It is critical to raise capacities of the WUA who will be in charge of water management, both in terms of technology application and in social organization. Farmers and their WUAs need to be able to use scientific tools and technologies for water management as well as for sustainable agricultural practices such as irrigation water and fertilizer input based on actual crop needs. This has to be accompanied by raising awareness.
- Strategies to involve local water users are most effective if double-edged, for example by combining water infrastructure rehabilitation with awareness raising. Local water user capacities and awareness of the importance of water monitoring at local levels can be supported by the availability of correct information on water to establish a database and documentation skills of the facilitation team.
- Communication, cooperation, and know-how exchange are imperative for sustainable water resource management. For instance, farmers in the Jordan Valley benefited a lot from the capacity building activities around participatory irrigation management, including workshops and field visits in Jordan and abroad.

Box 6.1. Lessons Learnt from Anjar and Kfar Zabad Hima in Lebanon

- Community based management represents an effective approach for improving the management of water resources leading to effective tangible results. As long as the communities are trusted for being keen to manage well their natural resources and provided with the necessary guidance and incentives they will be able to become the custodians of their own resources.
- After about a year of project implementation, a member of the WUA who is in charge of the management of canal rehabilitation and water distribution, reflected on the significant impacts of this project. He explains: *"This year I was able to sense the positive impacts of the canal rehabilitation on the management of water resources; while in the past year we had to recruit around 12 workers to clean those canals which resulted in spending a lot of money, this year we were able to do a lot of savings due to the canal rehabilitation work. This allowed us to invest the money we saved in improving other deteriorated pipelines within the system".*
- He also explained the positive impacts of the furrow irrigation on the lands of the water users association. He says:*"Through this approach we were able to save around 50% of water and get an improvement in production too. After applying this demonstration project successfully, we took a decision to adopt it in our WUA policy and promote it on the ground in order to be applied by all the farmers".*

6.1.3 Enhance and Facilitate Key Stakeholders' Strong Involvement at Local and Intermediate Levels

- Lobby for Water Users Associations (WUAs) or Watershed Committees to be established and legally recognized at watershed, water district or ground water basin scales throughout the country. Such WUAs or Watershed Committees should be closely involved in the design, planning and implementation of IWRM activities to develop and improve water resource policies and management.

- Future initiatives for participatory irrigation or other water resource management interventions need to identify with local society and water user groups -the drivers of change- that will trigger concerted action. Such drivers of change would provide guidance as well as justification for actions to be relevant and making positive impacts more significant. An example for an analysis of such drivers of change is provided in Box 6.2. below.

6.1.4 Promote Water Governance Reform Processes

- Engagement of relevant key stakeholders at intermediary and national levels has to be ensured early in the process of building decision-making approaches and tools. This, generally, will result in greater buy-in to the decisions made and creates new partnerships that help build stronger water management institutions. This also implies exploring new alliances between water managers, policy makers, community members, and scientists, as this can give support for jointly solving watershed management challenges at a sufficiently large scale to avoid unintended trade-offs in water benefits. It also is recommended to identify other legitimate and well-financed institutions that can take on other operation and maintenance of water infrastructure in support of other ministries with limited capacity.
- In all case studies/projects it appeared necessary to better clarify or define roles and responsibilities of different ministries working in the water sector (Water, Agriculture, Environment, Health …). At the same time, it is recommended to designate a specific authority to control and impose fines for better water management.

6.1.5 Document and Share New Insights and Learning

- In a number of projects lessons learnt and difficulties were well documented. It is indeed important to document the experience gained in solving obstacles when developing participatory irrigation management as was done for the case study on WUAs in the Jordan Valley. This unique experience in the Jordan Valley documents how a severely disrupted and ineffective irrigation system can shift to an effective participatory irrigation management by involving various social structures and levels.

Box 6.2. Lessons Learnt from the Jordan Valley in Jordan

- The case study on development of WUAs in the Jordan Valley (see Chapter 2.3) demonstrates that both farmers/water users and the Jordan Valley Authority (JVA) showed a high readiness to move from more or less “permissive participation” to very active participation in water management where operation and maintenance tasks were transferred from the JVA to the WUA. In this and many other cases this has to do with farmers being given the sense that they are dealt with as serious partners and are given clear responsibilities. The shift in tasks and responsibilities is essential for water user participation and for creating an eventually sustainable organizational basis for WUAs.
- As an outcome of a highly appreciated social and organizational learning experience here, it has become clear that farmers and their WUA are keen to pursue efforts “to reach efficient and fair water distribution to all farmers” as they formulated it themselves. They are eager to look for the future and to encourage junior farmers to engage and

work through WUAs, with the wish to further expand their capacities, tasks and mandates. As a result, in 2009, **more than 75% of the irrigated farming area in the Jordan Valley was managed in a participatory way by WUAs.**

- The support of a JVA, applying modern and participatory management approaches, was essential. Indeed, the farmers valued much such JVA's support; it changed their negative attitudes and increased their appreciation of the roles of JVA. The open and participatory ways of working resulted also in good internal governance of the WUAs. At the outset of the learning process some WUA leaders were happy to chair the association as this could bring prestige and societal position. However, when underperforming was signaled, the members of the WUA were able to change the leader. The newly developed ways of participative irrigation management links well with the traditional ways of farmers to manage their natural resources ("Hima"), that are based on equal rights and having a religious dimension as well. It is strongly recommended to utilize this unique feature in further developments and replication of the approach.
- The change processes that underpin such experiences often depend on a number of drivers. In this case these drivers of change were well understood and their potential effects well used. The drivers of change for both water users and the JVA in the Jordan Valley to come to better water resources management were:
  i. The urgency to sustain irrigated agriculture in the Jordan Valley;
  ii. The determination to avoid privatization of irrigation water;
  iii. The wish to avoid further use of Jordan Valley water resources for municipal uses or investment projects;
  iv. The determination to improve agricultural productivity and quality of life of the farmers and their associations.

6.1.6 Meeting SDGs

The lessons learnt summarized above are important to meet a number of SDGs that closely relate to water resource management. This applies here notably to SDG 6 *"ensure availability and sustainable management of water resources for all" and SDG 5 "achieve gender equality and empower all women and girls"*. As mentioned above, buy-in of water users, strengthening their technical and organizational capacities, facilitating involvement of key stakeholders, and water governance reform processes are all important ingredients to achieve these two SDGs. Emphasizing the roles, interests and empowerment of women is indeed critical to ensure access and rights to water for all and to enhance sustainable management and use of water resources. At the same time achieving such goals is a prerequisite for achieving SDG 15 *"protecting and restoring terrestrial ecosystems and to promote their sustainable use, while at the same time halting and reversing land degradation and biodiversity losses".* The 'Hima" case study on restoring and improving water management in a rich biodiversity ecosystem in Lebanon, and the pursuit of well-functioning water user associations in the water scarce Jordan Valley provide ample evidence on how the described approaches deliver sustainable results and in doing so contribute to SDGs.

6.2 Scaling-up Adaptive Water Resource Management in the Face of Climate Change

While this section deals specifically with water resources management in the face of climate change, there are also here strong dynamics of local water governance in play in most of the case studies discussed. Such water governance aspects valid also for the case studies under this chapter are discussed above and will not be further highlighted in this section. Working on adaptive action to face climate change and nurturing resilience of local people and ecosystems are also important to meet many of the SDGs here discussed.

6.2.1 Make Water a Key Element in Climate Change Resilience

- Effective country-driven climate change adaptation should reflect the importance of water management in reducing vulnerability and building climate resilience. Efforts to reduce greenhouse gas emissions also depend on access to reliable water resources, as all mitigation actions need water to succeed. Hence, adaptive IWRM needs to be placed at the centre of planning and investment for climate change adaptation, including the integrated management of land.

6.2.2 Work with Visionary Local Leaders

- Building climate resilience is dependent on the presence of visionary leaders, local champions, and capable practitioners. Consequently, working with and giving space to such local leaders will require well established adaptive governance capacity, i.e. the ability to device and apply in practice the adaptation measures from community to national and watershed scale. Ensuring good adaptive governance capacity requires local knowledge, access to resources, facilitation, leadership, mobilisation, and financing.
- In order to support such local leaders it is important to create both formal and informal opportunities for practitioners to communicate and share ideas, to focus on initiatives that bring tangible results at the early stage of planning, and to ensure widespread recognition of such championing innovation.

6.2.3 Use Appropriate Tools and Approaches

- The various climate change tools proposed and tested will only provide relevant guidance to identify the main climate risks and adaptation options and contribute to developing recommendations for integrated resilience strategies within national plans. Such tools are as good as the person (and his knowledge and experience) who makes use of them. An excessively mechanical use of these tools, such as simply prioritising discrete actions may lead to missed opportunities and wrong directions. This may jeopardize the effectiveness and the trust at local levels to build resilience in a dynamically changing environment, where uncertainty and unknowns are expanding.
- The SEARCH resilience framework that is tested and applied in a good number of projects that are described as case studies in this Knowledge Book presents a practical guide to mainstreaming climate change. It should be adopted as a strategy

for guiding policies, planning and investments across sectors, including economic planning, poverty reduction strategies, agriculture, energy and water resources development.

- It is important to bring such supporting actions to larger scales in order to increase impact and to build climate resilience by combining watershed management, sustainable infrastructure, empowerment and learning through adaptive institutions.

Box 6.3. Lessons Learnt in the Tangier-Tetouan Watershed, Morocco

- One of the main strengths of the project was the "technical team" that gathered the main stakeholders to actively participate in day to day decisions at a technical level. For this particular case the involvement was assured by:
  1) the involvement of the key institutions from the beginning to ensure synergic priorities and real decision making; and
  2) two level participation, at directive level (regional directors) and at technical level (technical team itself and appointed focal points for the project).
- The technical team has indeed constituted a real and practical platform for joint learning between stakeholders. It was very efficient in conducting the process internally and in the field, including facilitation of workshops and meetings with local communities and other stakeholders at different subnational levels. At municipality level, approaches for resilience assessment were largely appreciated, pilot actions were monitored by local authorities and there was a clear expression of interest in piloting "resilient municipal development plans" as proposed by SEARCH project. Important progress has been made also to disseminate and upscale experiences and outputs of the project. Furthermore, at regional level, capacity building was a core SEARCH outcome and advocacy messages were capitalized so as to meet other national initiatives. This has allowed the region to be selected, jointly with Marrakech Region, to coordinate an ambitious project dedicated to the creation of a center of expertise on climate change. Nevertheless, its role in institutionalizing SEARCH approaches for enhancing climate change resilience has been limited.

6.2.4 Engaging Legal and Financial instruments

- The success or failure of mainstreaming climate change into water management depends for a large extent on whether climate change has a place in national legislation. The ability of ministries to implement and enforce these laws and to reconcile the interests of traditionally powerful sectors with the interests of the more vulnerable water users is crucial.

- Financial tools for the sustainable management of water need to be developed alongside coalitions of water and energy utilities. Financing strategies will benefit from a blend of traditional water finance sources alongside specialist climate finance. Such strategies should promote investments and implementation that incorporates management, restoration and sustainability of natural infrastructure.

- Obtaining the backing at higher political levels for such instruments requires identifying and bridging the gaps in adaptive governance capacities that are needed to support resilience building processes. This would include engagement with and empowering of politicians by providing them with relevant information to better understand the societal costs of not working on resilience. This implies creating an environment where resilience champions and practitioners are encouraged to experiment with small-scale innovations that make incremental improvements on present practice.

6.2.5 Meeting SDGs

It is beyond discussion that working on adaptive water resources management to face climate change will also contribute to important SDGs as SDG 6 and 15 *(mentioned in section 6.1.6) and to SDG 13* "take urgent action to combat climate change and its impacts". Maybe, when working on adaptive action to face climate change will make it ever more important also to *"increase gender equality and empower women (SDG 5)"*, as in many cases good local water resources management is highly dependent on the commitment and responsibilities women take for that. The lessons learnt on working with visionary local leaders, using appropriate tools and approaches, and engaging the proper legal and financial tools, while making water a cornerstone in strengthening climate change resilience, are all also important to meet the SDGs here mentioned.

6.3 Scaling-up a Nexus Approach for Water, Energy, Food and Climate Change

While this section deals specifically with water resources management as a key element in a nexus approach to water, energy and food security, also here local water governance plays in most of the case studies discussed an important role. Collective work, participation of stakeholders and local communities in the planning processes is also in a nexus approach fundamental for connecting scales and solutions. Such water governance aspects however, will not be further highlighted in this section. Within a nexus approach they are however critical to meet SDGs as illustrated in the sections above. Integrating action through a nexus approach, creating synergies among closely linked sectors as food, water and energy (and climate change resilience) will certainly make such actions more efficient, effective and sustainable.

6.3.1 Emphasize Sector Integration by Implementing Nexus Approaches

- A nexus approach integrates management and governance across sectors and scale, while it also will support the transition towards greener economies that aim, amongst others, at resource use efficiency and greater policy coherence. There is no need however for new governance structures, rather adapt existing collaboration mechanisms. Institutions, including development partners, need common objectives and new metrics such as the economic efficiency of water or power use.

6.3.2 Privilege Local Actions

- While it is important to acknowledge the importance of scale, win-win solutions can often be easily realized at local levels. Here innovative and affordable local actions can quickly contribute to improved social, economic and environmental benefits. This would also be an argument to go for decentralised planning and implementation. There is still a work to enlarge 'mini nexi' with local champions instead of striving to get everybody on board from the onset (from case studies to development models). In the nexus process, see how to build equitable value chains based on compromise and to adopt market-based approaches. Nevertheless, regional solutions to local problems and investments in natural infrastructure have the potential both to increase supplies of water and/or energy, and increase economic efficiency in both sectors.

6.3.3 Enhance Legal and Institutional Frameworks

- Also for nexus approaches legislative and institutional frameworks are needed to enable the environment for collaboration amongst relevant institutions for coordinated decision making. In many countries this requires new capacity building for policy makers and planners that goes beyond their day-to-day remits. It is advised to stimulate that to create a pool of national and regional group of competencies with a solid Nexus knowledge and a connection to policy sphere.

6.3.4 Undertake Awareness Raising on the Advantages of a Nexus Approach

- Awareness raising and information sharing are basic for behavioural changes towards better and more sustainable practices also with a WEF nexus. This will also require proper knowledge management practices. Working with champion countries that have already embarked on some form of cooperative governance and coherent planning for sustainable development is recommendable. It is useful here to provide context specific evidence with rigorous research transaction costs and sector gains while adopting the Nexus approach.

6.3.5 Meeting SDGs

The lessons learnt under this theme illustrate how important it is to align local initiatives, promote sector integration and enhance legal and financial frameworks to achieve sustainable water resources management and hence a good number of SDGs, such as SDGs 5, 6 and 15 (mentioned earlier), but also SDG 7 *"ensure access to affordable, reliable, sustainable and modern energy for all"*. Applying nexus approaches that seek synergy between actions undertaken for different sectors can only further strengthen sustainability.

Box 6.4. Lessons from Ehnasia District in Egypt

A National Policy Workshop was organized by the SEARCH project in Egypt to share results and how these results have been obtained with concerned stakeholders[1] on followed nexus approaches. Four groups of recommendations came out of this workshop.

Participation: This includes community participation and capacity building to meet the climate change challenges within a nexus approach, while encouraging the participation of the private sector and civil society to support innovative ideas to adapt to climate change; and maximizing the role of civil and private funding for mobilizing resources to address climate change challenges.

Dissemination: Develop guidelines/manuals for action and data and information basses to make new knowledge and insights available to all concerned stakeholders and civil society; focus on education and capacity development of employees to raise awareness; and implement pilot projects that achieve social and economic successes on the ground, while increasing the resilience of socio-ecosystems; ensure coordination and linking with other climate change projects in Egypt to share knowledge and information.

Thinking and Behavior Change: Adopt innovative approaches to adapt to climate change; and capacity building on all levels, including decision makers. Important emphasis is on facilitating new thinking and behavioral change so as to allow giving space to new ideas, such as the introduction of new crops that can withstand climate changes; cultivate crops that combine high cash and nutritious values with low water consumption; create new industries based on these crops.

Policy: Policy coherence is needed in relation to water, energy, agriculture and climate change, as they are closely interlinked; knowledge on the climate situation should be improved through studying soil, water and climate in an integrated manner; improving the governance structure and activating the role of the joint ministerial committees; necessity of networking and joint work among all relevant institutions and civil society representatives; lastly, while working at the national level (strategies and plans) on climate change has taken time and effort, it is now time to move to lower levels (governorates, districts and villages), and build the linkages.

6.4 Scaling-up Innovative Sustainable Water Technologies

Developing innovative and sustainable technologies in the water sector cannot be seen in isolation from water governance processes, action to tackle climate change challenges and nexus approaches that create win-wins among different sub-sectors. Within the interactions with these other dimensions of IWRM this section will zoom-in on technologies themselves. Innovating technology in rapidly changing environments is a must to achieve sustainable water resource management and through that meet many of the SDGs.

[1] Including Ministries of Water Resources and Irrigation, Agriculture, and Environment, the National Water Research Center, Environment and Climate Change Institute, Shores Protection Institute, Central Laboratory for Climate, CEOSS, Maiana Village Civil Society and CEDARE.

6.4.1 Engage and Facilitate Key Stakeholders

- Engaging stakeholders in all phases of technology selection, assessing, and imple-mentation, will help in overcoming unforeseen problems and challenges. Ensuring participation of all relevant stakeholders needs to be done at different levels (community, governorate, and national) and allowing for different skills and experi-ences to overcome challenges, and develop and support the ideas that led to the innovations.
- A good facilitation process is a must to interact with multiple stakeholders at different levels, close gaps, unify views, develop and support the innovation in terms of repli-cation and dissemination.
- Effective collaboration and coordination, a shared vision, and building strong net works among all actors to better understand and disseminate the ideas will contribute to sustain efforts.

6.4.2 Develop Good Knowledge of the Physical and Social Environment

- The implementation of innovations and technologies requires comprehensive and indepth knowledge of the social and physical environment for adequate technology application. Knowing and understanding the impacts of technologies to be applied can help overcome the risk of break down or failure.

6.4.3 Build Capacities for Innovation

- For sustainability of technological innovation, capacity building and strengthening of skills of local and institutional staff are required to operate and maintain such tech-nologies effectively.
- Raising awareness about the use and benefits of innovated technology needs to be done also within local communities

6.4.4 Engage in Documenting Innovation Processes and Mobilizing Funding

- Process documentation during and after technology implementation is crucial for scaling up as well as understanding of the situation where it was applied and impacts achieved. Assessing and sharing progress in technology needs, gaps and achieve-ments on a routine basis is helpful to amend decisions by stakeholders and policy makers.
- Documenting processes and achievements is necessary also for mobilizing required funding for up-scaling, implementation, operation, and maintenance activities. This also relates to lobbying at the national level for the need for new innovations and technologies to address water issues and improve certain conditions.

Box 6.5. Lessons from Marj Sanour Watershed in Palestine

- A comprehensive participatory and multi-stakeholder-led approach to development has provided the foundation for a well-defined watershed development plan that has led to important tangible results with long-term impact. More work and investments are however still to be done to minimize the risks of flood and drought and provide a long-term perspective for the livelihoods of people in this valley. A watershed committee has been established that is recognized by all parties and serves overall watershed coordination among the 7 communities in the watershed and external stakeholders.
- Key in such a participatory planning process is a transparent and accountable way of communicating and consulting with all parties involved. As mentioned by farmers and watershed committee members this requires patience and confidence, and time to give space for reflection and decision-making.
- While the Marj Sanour watershed has its own specificities, similar processes are workable at smaller and larger scales. The methodologies have demonstrated to be easy to be implemented also with local farmers, including women. Such social organization processes are feasible at community level if started with a long-term development horizon and the identification of a critical shared interest that has urgency to be resolved.

6.4.5 Meeting SDGs

Also under this thematic area, the case studies provide ample evidence of how important it is to engage with key stakeholders, develop the right knowledge of the physical and social environment, engage and mobilize knowledge and funding and most of all to build capacities to be innovative, both in social and technological terms. The lessons learnt in the different case studies also provide pathways to meet SDGs, be that for ensuring water availability and sustainable water management for all (SDG 6), affordable and reliable energy for all (SDG 7), take the necessary action to combat climate change (SDG 12) and protect and restore ecosystems and their sustainable use (SDG 15).

As an overall conclusion working on actions to meet SDGs in the water resources sector demands to exploit the potential win-win situations that can be achieved by enhancing local water governance modalities, while working at the same time in a nexus approach to serve inter-sectoral integration and synergy of action.

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