40 Years of German-Jordanian Technical Cooperation in the Water Sector

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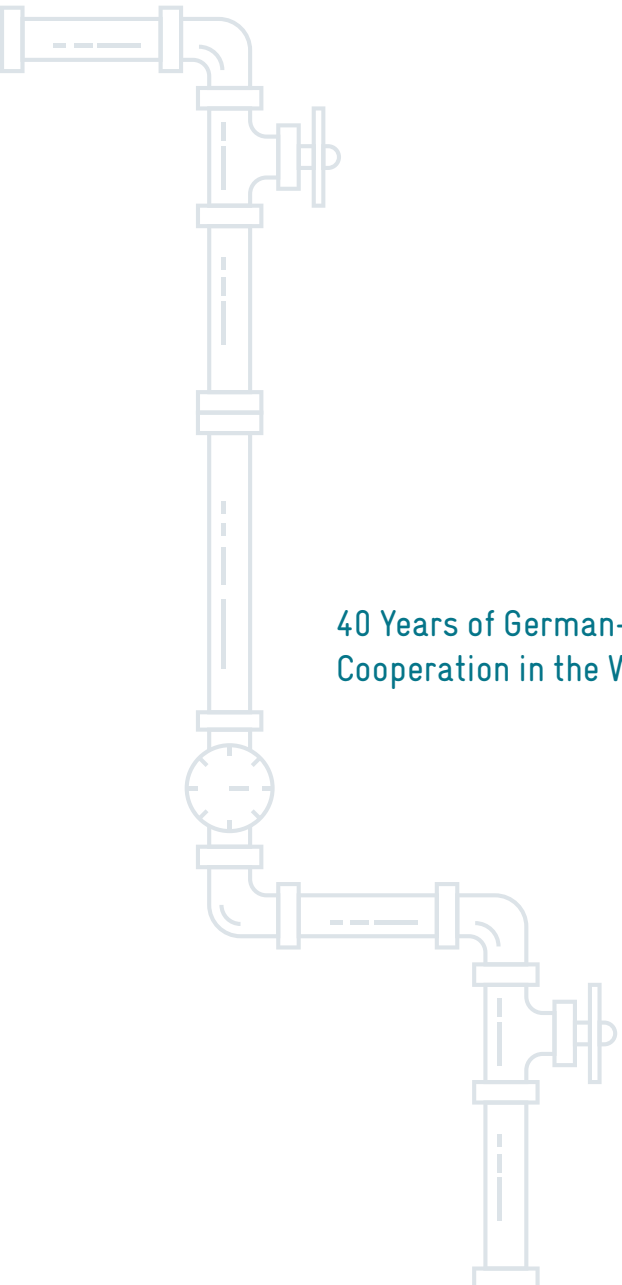

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40 Years of German-Jordanian Technical Cooperation in the Water Sector

Preface

Placed at the crossroads of Asia, Africa and Europe, largely comprising deserts and semi-arid lands and yet part of the Fertile Crescent, Jordan is a naturally water-scarce country steeped in human history. Following its independence in 1946, a mere half-million lived in the territory. Today, however, Jordan hosts roughly ten million people – among them several million refugees from Palestine, Syria, Iraq and other neighbouring states who were welcomed throughout the decades. While the shortage of water has been dominating people's lives at all times, it is particularly because of the ever-increasing population which need to be supplied with clean drinking water and the agricultural production that groundwater resources have been continuously over-exploited and surface water bodies are drying up. Additionally, people are beginning to feel the impact of climate change and the more and more irregular precipitation patterns. Even though today almost every household in Jordan is connected to the water supply network, the quality and reliability of service provision have been declining as resources dwindle and the sector institutions struggle with financial constraints.

In early 1967, the Hashemite Kingdom of Jordan was among the first Arab states to re-establish diplomatic relations with the Federal Republic of Germany, leading to the development of an ever since continuing development cooperation programme. In consequence, GTZ/GIZ has been supporting the Jordanian water sector in tackling its many challenges for over 40 years: Between 1975 and 2016, a total of 30 projects were commissioned with an overall budget of more than 110 million Euros. The longevity and volume of this water portfolio give rise to questions regarding the development of the cooperation itself: What were the thematic key areas, and how did they evolve over time? What impacts were achieved, and could these be sustained until today? What are the lessons learnt?

In this report, we strive to present answers to these questions. Instead of attempting to provide an in-detail evaluation, however, our team of sector experts (consultants) interpret the developments from their personal

perspectives. To this end, they analysed hundreds of documents provided not only by GTZ/GIZ but also by the *KfW Development Bank*, the *German Federal Institute for Geosciences and Natural Resources* (BGR), as well as the *Jordanian Ministry of Water and Irrigation*, the *Water Authority of Jordan* and further local institutions, and conducted interviews with more than 70 representatives of the Jordanian water sector and international experts in late 2016 and early 2017. Based on the results, the authors illustrate the progress and outcomes of German-Jordanian technical cooperation in the water sector in five thematic key areas.

Focusing on strategies for managing water scarcity starting in 1975, Mathias Polak begins by analysing technical cooperation in water policy drafting from the National Water Master Plan up to the National Water Strategy. In the second chapter, Dörte Ziegler depicts the operation and management support provided from 1993 onwards for the professionalisation and commercialisation of public water and sanitation services. In 1994, the promotion of stakeholder participation in water resources management, in the allocation of irrigation water, and beyond became an area of intervention – Mathias Polak traces these developments in the third chapter. Since 1995, GTZ/GIZ has been contributing to enabling the reuse of treated wastewater for agricultural irrigation in order to protect the scarce freshwater resources, as Detlef Bockelmann and Matthias Schmidt describe in the following. Finally, Elke Zimmermann investigates the joint efforts for reducing energy intensity in the water sector in 2006 and after in the fifth chapter.

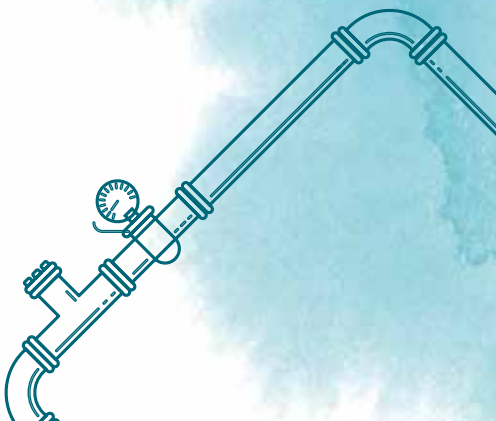
The different chapters reflect the personal views of the authors which do not necessarily reflect the views of GIZ.

This study would not have been possible without the generous assistance and helpful insights and inputs of many people. This includes GIZ Country Staff, in particular Daniel Busche and Franziska Bock, but also numerous persons from the *Ministry of Water and Irrigation*, the *Water Authority of Jordan*, and the *Jordan Valley Authority*. I would especially like to thank HE Dr. Hazim El-Naser, the former Minister of Water and Irrigation, as well as HE Eng. Iyad Dahiyat, the former Secretary General of the *Ministry of Water and Irrigation* and current Secretary General of the *Water Authority of Jordan*, HE Eng. Tawfiq Habashneh, the former Secretary General of the *Water Authority of Jordan*, and HE Eng. Saad Abu Hammour, the former Secretary General of the *Jordan Valley Authority*, for their kind support

throughout the research phase of this project. Not only did they take the time for meeting the authors and sharing their personal perspectives and experience with them, but they also granted us access to the sector's wealth of knowledge through their employees, their data and documents – without these, the development of the report would not have been possible.

Frauke Neumann-Silkow
Head of GIZ Water Portfolio in Jordan

Amman, 24.09.2018



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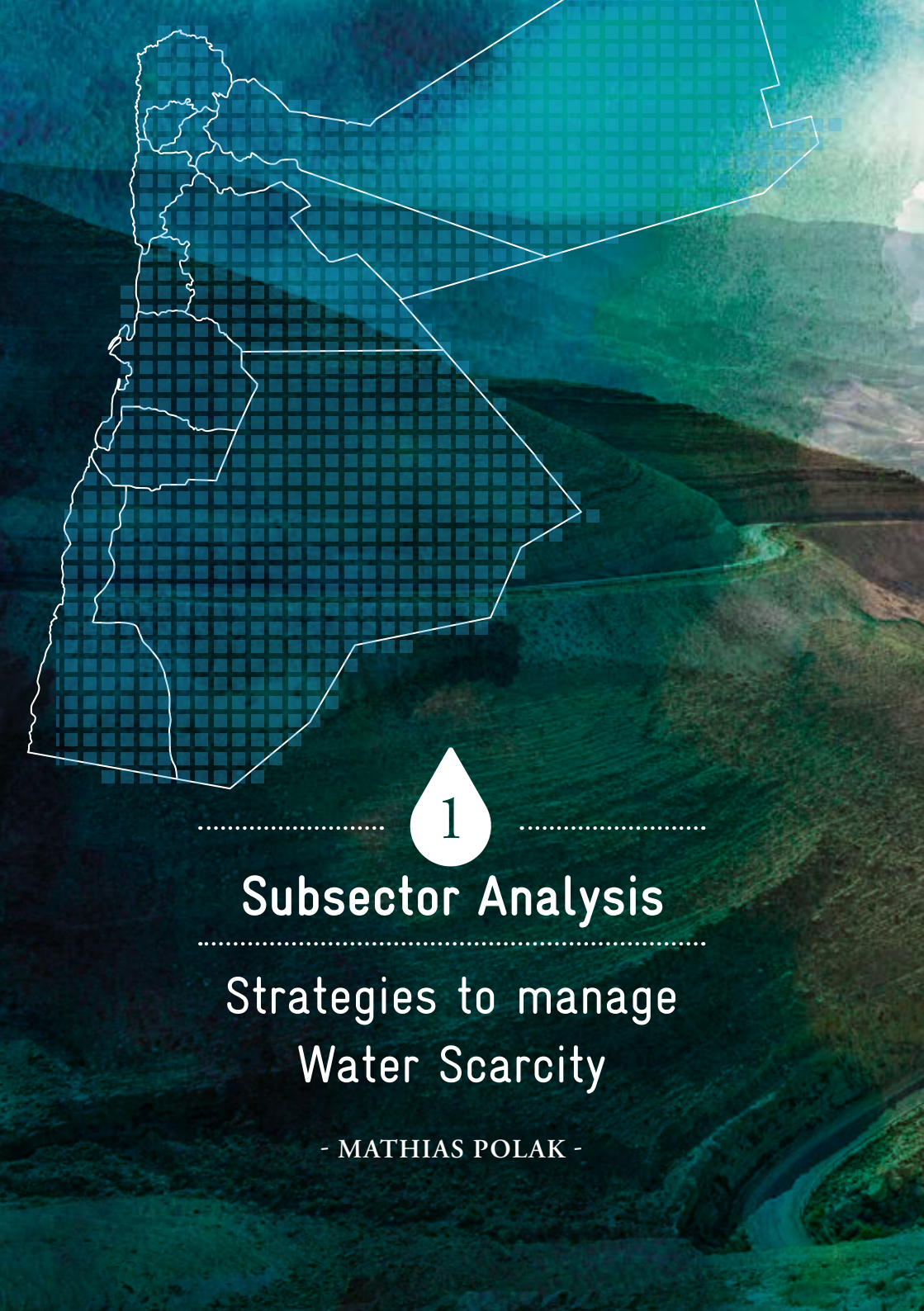
List of Abbreviations

ACSAD	Arab Centre for the Studies of Arid Zones and Drylands
ACWUA	Arab Countries Water Utilities Association
AFD	French Development Agency
AGWA	Amman Governorates Water Authority
AWC	Aqaba Water Company
BGR	Germany's Federal Institute for Geosciences and Natural Resources
BMZ	German Ministry for Economic Cooperation and Development
BOT	Built-Operate-Transfer
BWP	Brackish Water Project
CSS	Comprehensive Subscriber Surveys
DC	Development Cooperation
DCMMS	Dorsch Consult Maintenance Management System
DM	Deutsche Mark
DPP	Development-Partnership Projects
DSS	Decision Support System
ETIP	Evaluation Tool for Investment Planning
EUR	Euro
FTA	Farm Turnout Assembly
GDP	Gross domestic product
GIS	Geographical Information Systems
GIZ	German Agency for International Cooperation
GTZ	German Organisation for Technical Cooperation
HDPE	High Density Polypropylene
HTML	Hypertext Mark-Up Language
HWF	Highland Water Forum
IEE	Improving the Energy Efficiency of WAJ Project
IFAT	Trade Fair for Water, Sewage, Waste and Raw Materials Management
IMT	Irrigation Management Transfer
INDC	Intended Nationally Determined Contribution
IWA	International Water Association
IWRM	Integrated Water Resources Management
JFDA	Jordan Food and Drug Administration
JOD	Jordan Dinar
JVA	Jordan Valley Authority

KFW	German Development Bank
MCM	Million Cubic Meters
MENA	Middle East and North Africa
MoA	Ministry of Agriculture
MoPIC	Ministry of Planning and International Cooperation
MWI	Ministry of Water and Irrigation
MYWAS	Multi-Year Water Allocation System
NCARE	National Centre for Agricultural Research (NCARE)
NRA	Natural Resources Authority
NRW	Non-Revenue Water
NWMP	National Water Master Plan
O&M	Operation and Maintenance
OMS	Operation and Management Support
PDF	Portable Document Format
PMU	Project Management Unit
PPP	Private-Partnership Projects
PSP	Private sector participation
P&L	Profit and Loss
SCMP	State Crop Monitoring Programme
TC	Technical Cooperation
TTA	Task Transfer Agreement
UNDP	United Nations Development Program (UNDP)
VBA	Visual Basic for Applications
WAJ	Water Authority of Jordan
WEAP	Water Evaluation and Planning
WIS	Water Information System
WUA	Water User Associations
YAC	Yarmouk Water Company



1

Subsector Analysis

Strategies to manage Water Scarcity

- MATHIAS POLAK -

1.0 Strategies to manage Water Scarcity

Mathias Polak

1.1 Challenges for managing Water Scarcity

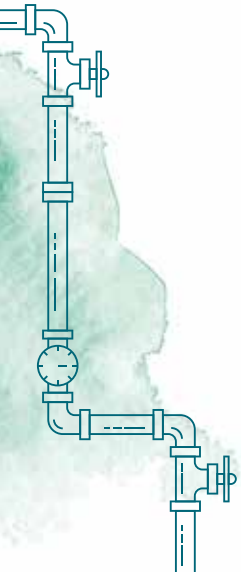
Lack of coordinated Planning as key challenge.

Jordan as one of the water scarcest countries on earth started many decades ago to develop strategies to deal with scarcity. Germany is supporting the development and implementation of these strategies since 1977. National water master planning encompasses the process of identifying available water resources, forecasting future demand, monitoring population growth and economic development, listing priorities and finding alternatives and substitutes for the declining resources. This also includes igniting discussions about compromises between sectors about limited resources and how to make best use of these resources. The support to this process was Germany's entry point into Jordan's water sector in 1977. The ultimate task remains the same until today (2017): finding ways and processes to strike a balance between available water resources and water consumption.

Jordan ran into a water deficit in the 199os, i.e. the amount of water used in the country was bigger than the available renewable resources. This challenge was known since the 1970s *(see chapter 4 below)* and national water master planning was the key undertaking to turn this situation around and to balance demand and availability. The core problem GIZ encountered in the support of this process is multidimensional and encompasses the following aspects:

- insufficient information basis for decisions
- insufficient legal provisions to address challenges
- no political consequences taken from known challenges
- limited capacities of sector institutions for enforcement.

These problems were identified in the first *National Water Master Plan* (NWMP) of 1977. The following chapter analyses GTZ's/GIZ's support to national water master planning and tries to explain why the core problem is as urgent in 2016 as it was four decades ago.



Timeline of GTZ/GIZ-support

Support at strategic and technical level.

GTZ/GIZ's approach over the past 40 years has been modified several times and very different instruments were developed in the course. The following *Fig. 1.1* summarizes the different phases of support. The main areas of support were the first NWMP in 1977, the digital NWMP launched in 2004 and the decision support system WEAP, which is under development until 2016. These technical instruments were guided by three National Water Strategies published in 1997, 2008 and 2016, whose development was supported by GTZ/GIZ.

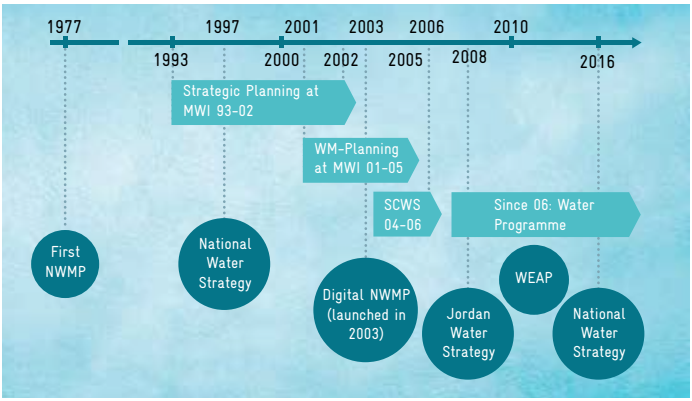


Figure 1.1
Timeline of GTZ/GIZ-support to the Management of Water Resources

Source: Own compilation

A major challenge for the sector and for GTZ/GIZ's support were the fundamental changes in framework conditions. In 1972, Jordan's population was at about 1.7 M. (BfB 1974, p. 13) and industrial production was virtually non-existent. Over the past 45 years, population has multiplied by six and Jordan developed into a middle-income country. This effected water demand both for domestic and industrial purposes as well as for agricultural products. The Syrian refugee crisis since 2011 added a new dimension to the already rapid population growth. Between 2011 and 2016, Jordan's population increased by close to 50%; from 4.3 M in 1995 to about 6.5 M in 2010 to about 9.5 M in 2015 (UNICEF 2016)

Many planning decisions became obsolete or implementation was not feasible anymore due to these changes. The drastic increase of water demand is one explanation why national water master planning is highly challenging in the Jordanian context. Another aspect that makes planning difficult is Jordan's dependence on external water sources. Intensified land use and changing water use patterns in Israel, Lebanon and Syria increased uncer-

tainties for the Jordanian planners. However, beyond changing and sometimes unknown framework conditions, a critical analysis of GTZ/GIZ's support is required to understand why support is still needed after four decades.

1.2 1977: The first National Water Master Plan

NWMP was the first comprehensive oveview on Jordan's water resources.

In 1975, the *German Ministry for Economic Cooperation and Development* (BMZ) provided 1.4 M DM for the development of a *National Water Master Plan* (NWMP), a project that was part of Jordan's Five-Year Plan 1976–1980. In April 1976, a multi-disciplinary Jordanian-German team began with the preparation of the first NWMP. The *Natural Resources Authority* (NRA) in Amman acted as counterpart for the project, which was implemented by *Germany's Federal Institute for Geosciences and Natural Resources* (BGR) and the *German consulting company* AHT on behalf of the 1975 founded GTZ. GTZ did not provide own personnel for the NWMP, but acted as principal on behalf of the commissioning German Ministry.

1.2.1 Objectives and Key Findings

The NWMP was meant to provide a comprehensive overview on the available water resources and the current uses in Jordan. Based on this assessment, recommendations for a "nation-wide water allocation programme" were formulated. These recommendations were "intended to be of help in the making of high-level decisions on the policies and strategies to be adopted for the optimum utilization of water resources" (NRA and GTZ 1977, ii).

Particular objectives of the project included (BfB 1974, p. 48):

- assessment of water sector situation in the whole of Jordan and chronological listing of necessary measures to achieve medium-term (1985) and long-term (2000) objectives
- giving recommendations for further investigations
- setting of priorities of water use, if water is not sufficient for all demands; in this case: Development of a "water rationing programme" for farms with surface water irrigation.

Expectations of the Jordanian side included (BfB 1973, p. 4):

- optimization of economic benefits through improved water use
- reduction of costs of water development
- reduction of water scarcity in some regions and avoiding water surplus in others
- creation of basis for future water projects
- setting of priorities and standards for future water fees
- creation of basis to apply for foreign development aid.

A crucial feature of the 1977 NWMP was its character as a living document: "Projections, however, seldom come true and available background data are not consistent in all cases. The Plan and the various conclusions should therefore be reviewed in intervals of about five years and extended accordingly" (NRA and GTZ 1977, p. 62). Hence, the authors were well aware of the limitation of available data. Therefore, further and continuous investigations on water resources were described as indispensable: "The present plan is to be seen as the first approach to the formulation of a coordinated water allocation policy for Jordan. The constraints originating from the existing database have been noted. Nevertheless, the most urgent policy decisions can be based on the plan, as long as the documentation remains subject of systematic updating work. The conclusions may have to be modified in due course, and there might then have to be a corresponding adaptation of policy decisions" (NRA and GTZ 1977, p. iv).

NWMP was planned as a living document that required continuous updating.

The First Water Balance

Based on the overall water balance for Jordan *(see Table 1.1)*, the NWMP of 1977 concluded that by the year 2000, Jordan is likely to run into a water deficit, if not appropriate countermeasures would be taken.

Table 1.1
Water balance Jordan

Sources:
1) NRA & GTZ 1977, p. 23;
2) MWI 2008, p.1-4; 3) MWI 2016, p.11

	Available Water Resources (in MCM)	Water Demand (in MCM)
1977[1)]	Total: 1.100 • Surface water: 800 • Groundwater: 220	Total: 451 • Agriculture: 405 • Domestic and industrial: 46
Projected 1985	Total: 1.100 • Surface water: 800 • Groundwater: 220	Total: 910 • Agriculture: 730 • Domestic and industrial: 190
Projected 2000	Total: 1.100 • Surface water: 800 • Groundwater: 220	Total: 1.100 • Agricultural: 800 • Domestic and industrial: 300
2007[2)]	Total: 1.161 • Developed surface water: 295 • Safe yield groundwater: 275 • Non-renewable groundwater: 91 • Return flow: 55 • Treated wastewater: 91 • Desalinated water: 10 • Peace treaty water: 50	Total: 1.566 • Agriculture:1080 • Domestic and industrial: 446
2016[3)]	Total: 832 • Surface water: 265 • Safe yield groundwater: 275 • Non-renewable groundwater: 145 • Treated wastewater: 140 • Additional sources (desalinization + swap): 11	Total: 1.403 • Agriculture: 700 • Domestic and industrial: 703

1.2.2 Recommendations of the first National Water Master Plan

In order to address the foreseeable water deficit, the NWMP recommended actions in four major fields:

NWMP provided highly relevant recommendations from today's perspective.

Determination of Water Resources Allocation Policies

This recommendation addressed the need for high-level policy decisions about the allocation of water between sectors. The below mentioned institutional structures should formulate such high-level policies as a general framework for actual allocation decisions such as the granting of water rights.

Administration and legislation

"All activities related to the implementation of the NWMP are to be guided and controlled by a high authoritative Government body. It has to coordinate the agencies involved" (NRA and GTZ 1977, p. 60). This high authoritative Government body was already conceptualized in the Five-Year Plan 1976–1980 as "Supreme Water Council". This council was supposed to consist of representatives from different sector institutions and should have the following functions (ibid, p. 65):

- determination of water resources allocation policies and strategies for the final formulation and approval of the NWMP
- coordination of activities of executing agencies
- licensing and cancelling of water rights
- approval of plans for water resources utilization and allocation of funds
- supervision of water use in accordance with established policies
- instructions for issuing of bills for legislation, norms, and standards related to water use and water quality control
- instructions for survey and studies/research regarding water resources and water use
- reconsideration of programmes and plans for periodical review and updating of the NWMP.

Pollution Control and Recycling of Water

Avoiding the pollution of water resources was seen as a crucial step to secure the available amount of water. Also, repeated use of water was seen as indispensable, especially in demand centres for domestic and industrial use (i.e. large cities). The reuse of treated wastewater in agriculture, which became an important element to substitute freshwater use was not yet contained in the 1977 NWMP.

Data Acquisition and Information Management

Data gaps were identified in the course of development of the NWMP particularly with regard to the availability of water resources. The necessary legal arrangements for the implementation of the NWMP should further provide obligatory guidelines and instructions for a regular flow of information between all agencies concerned with the control and the use of water resources. The monitoring system was meant to cover all data on actual and expected water and water management, achievements of water quality control and the information regarding detailed studies on water resources and related development projects. Such information management

was considered crucial for the maintenance of up-to-date information in order to facilitate adjustments and improvements of the Plan.

Institutional solutions for multi-sector coordination were also proposed.

Apart from these four main recommendations, the NWMP proposes a number of short-term measures and emphasizes the need for a continuous updating of the NWMP. These recommendations are very up-to-date and are still of high relevance. Especially the proposal of a Supreme Water Council as a multi-sector coordination mechanism as well as the request for licensing of abstraction and enforced water rights have been voiced over and over by national and international water experts ever since. This illustrates the value and clear-sightedness of the 1977 NWMP. However, at the time of handing-over the NWMP, German technical assistance did not yet focus on capacity development or supporting the partners to institutionalize the approach. The implementation of the recommendations, including the challenging institutional questions, were considered exclusively Jordanian business.

1.3 1991 – 1997: Support to the Strategic Planning Unit of MWI

New Ministry as a window of opportunity for national water master planning.

Although the Supreme Water Council remained a vision, the *Ministry of Water and Irrigation* (MWI) was established in 1992. Soon after, GTZ started to support the organizational development of the new Ministry. Starting point both for the establishment of MWI and for the German support was the growing awareness for Jordan's water deficit. Through the GTZ support, MWI should be enabled to strengthen planning in the water sector with respect to sustainability, i.e. to strive towards achieving a balance between water use and water availability.

Developmeant of first political guidelines for the water sector.

While the idea of the 1977 NWMP being a living document did not materialize, the plan still served as a reference document on Jordan's water resources throughout the 1980s and large parts of the 1990s. Within the new GTZ-project, the intuition objective was to update the 1977 NWMP. However, in accordance with the 1977 recommendations it was decided that the water sector required first political guidelines to which planning procedures could be aligned. Therefore, the project concentrated on supporting the development of strategy and policy papers that formed the basis of Jordan's first National Water Strategy of 1997 and related sub-sector policies. This Strategy marked a major shift in Jordanian water policy as the sector evolved from a focus on supply and services, with the public

institutions managing large investment programmes, to one paying more attention to management and efficiency on both demand and supply sides. The Strategy had the goal to use available renewable resources as efficiently as possible through tailoring water demand to what water could be made available at reasonable cost and with the lowest environmental impact. Specific objectives included (Yorke 2013, p. 39):

- reducing extraction from depleting groundwater resources
- curbing irrigated agriculture in the Highlands so water saved could be used for more productive sectors
- using treated wastewater to increase irrigation in the Jordan Valley to reduce food imports
- improving the performance of institutions through increased private-sector participation, promoting cost recovery for the supply of sevices,
- reducing non-revenue water, and
- encouraging regional cooperation.

With these objectives, the National Water Strategy paved the way for other fields of intervention of GTZ support such as the use of brackish water and treated wastewater in agriculture *(see chapter 4)* as well as operations and management support for utilities *(see chapter 2.4).*

The Strategy was complemented by four particular policies on

1) groundwater
2) water utilities
3) wastewater reuse and management as well as
4) irrigation water.

An investment programme and an action plan were developed for the years 1997–2010 and updated in 2002 to extend until 2011. The investment program was completely implemented except the major project of the Red-Sea-Dead-Sea water transfer.

The introduction of new topics and objectives in the sector required a number of legislative amendments such as the reformulation of Article 28 of the *Water Authority of Jordan* (WAJ) law to allow for private sector participation (2002) as well as the Groundwater Law (2002) and its Bylaw (2004) aiming at the protection of groundwater resources. Hence, the strategy of 1997 was a first major step to modernize the sector framework and to align

the sector to the objective of sustainability. The NWMP was considered a necessary instrument to put these political guidelines into practice and became a major topic for GTZ support in the following years.

1.4 1997 – 2004: Digital National Water Master Plan

During the 1990s, it became increasingly clear that the analysis contained in the NWMP of 1977 were outdated and did not fit anymore the requirements of national level planning. MWI decided to develop a new com prehensive framework that outlined, analysed and addressed all aspects of the country's water situation. Despite the provisions of the 1977 NWMP, it was never updated or used to decide questions of allocation between subsectors. The creation of MWI in 1992 altered the institutional set-up of the water sector and opened a window of opportunity for effective sector planning. In consideration of the rapid developments of information technology in the 1990s, it was decided that a digital version of the NWMP was to be developed that would provide a framework for the future development of the water sector. This digital "toolbox" was to help assessing future impacts of measures on the water budget and proposing solutions for achieving a balance between water resources and demand, thus assuring the availability of sufficient water supply to all users.

Hence, the key elements of the digital NWMP (MWI; GTZ 2004) were a

- description of all available water resources (surface water, groundwater, unconventional water sources)
- forecast of demands in the different subsectors (domestic, industry, including tourism and agriculture) for different planning horizons
- options for technical and operational measures to balance availability and projected demands.

The digital NWMP was realized in a modular structure with nine thematic chapters: Irrigation water requests, domestic water demand, industrial water demand, agricultural water demand, groundwater resources, surface water resources, treated wastewater, water balancing and allocation of resources. The digital NWMP provided guidelines for balancing water demands and resources *(see Fig. 1.2*). In order not to overuse the available resources, especially renewable groundwater, water demands were meant to be tailored in accordance with what water can be made available at

reasonable cost and with the lowest possible environmental impact. It was clear from the beginning that a key element of successful water resources management for the future would be the institutionalization of the development corridor outlined by the NWMP. All institutions within the Jordanian water sector were supposed to adhere to the recommendations and demand figures for their future planning for the management and operations of water supply and sanitation systems.

The electronic format of the NWMP brought several big advantages: portability (the whole document fitted onto a CD-ROM) and easy navigation within and between the various parts and layers of the document.

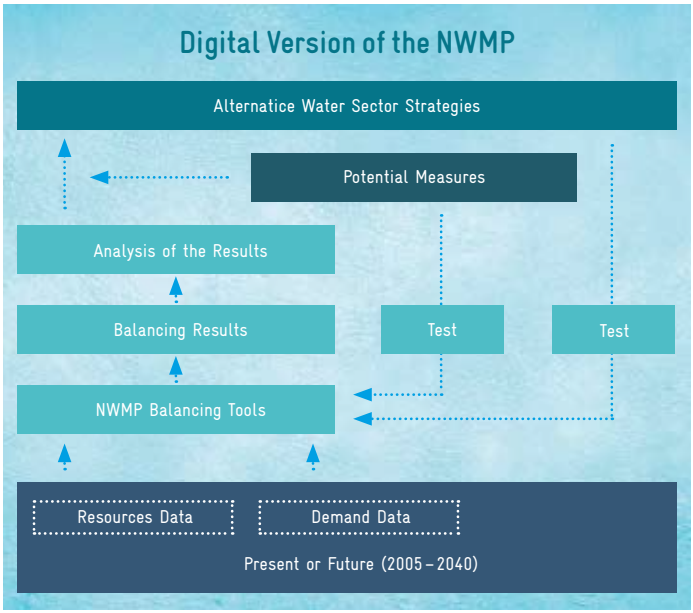


Figure 1.2
Schematic overview on digital National Water Master Plan

Source:
GTZ (2004, p.10)

Most important, however, was the facility to easily update the document. The NWMP was meant to be updated constantly by the responsible sector institutions under the coordination of MWI. Changes in availability of water resources (e.g. through increased use of treated wastewater or changes in groundwater abstraction) and changes in demand (e.g. through population growth and economic development) were supposed to be included in the document as soon as possible, i.e. at least on an annual basis. In order to obtain this functionality, two additional features are required. First, the document was composed of a standardized structure of small individual units

Constant updating of data was foreseen.

linked with each other. It was agreed to use system-independent file formats HTML (hypertext mark-up language) and PDF (portable document format). Secondly, an additional software shell was required to convert the "raw documents" into the agreed document formats in order to integrate them into the overall structure of the digital master plan.

1.4.1 Principal Technical Components

Water Information System

The Digital Water Master Plan received its data from the *Water Information System* (WIS), which was established with support of GTZ and serves as the backbone of the MWI's IT-system until nowadays. It is operated by the Ministry as well as WAJ and *Jordan Valley Authority* (JVA). In addition, the WIS is the authorized source for data on water monitoring, management, and planning for external users like research institutions or international donors. The WIS is a complex system of hard- and software, data and tools as well as people for its *Operation and Maintenance* (O&M). It can be accessed from all computer workplaces within the Ministry's network. The majority of data is either stored in OR-ACLE data base tables or in *Geographical Information System* (GIS) files. These two data systems are linked, thus permitting both the data selection by interactive maps and cartographic representation of results. The WIS contains monitoring data collected in the field either by operators of the water supply and wastewater disposal systems (especially WAJ and JVA), the hydrological service of the Ministry and/or external institutions like the Department of Statistics and the *Ministry of Agriculture* (MoA).

One major database for the water sector.

In addition to the monitoring data, the WIS holds the results of water demand and resources projections. In order to facilitate data exchange between the involved institutions, a unified coding compulsory for all water authorities (JVA, WAJ and water supply companies) was supposed to be developed. It is obvious that the WIS is an ambitious system in terms of interagency coordination and exchange. Therefore, institutionalization was a priority on GTZ's agenda from the beginning, but turned out later on to be an Achilles´ heel of the NWMP *(see below)*.

Digital Planning Tools

The second key element of the NWMP's technical structure were the Digital Planning Tools, a set of interactive software modules applied to

forecast water resources and demands for future development scenarios. These forecasts used recent monitoring data as a starting point. The results were stored into the so-called Scenario Tables Pool, which were part of the central ORACLE database administered under the WIS. From there, the information on future resources and demands was taken for nation-wide water balancing.

These software tools are database applications with a GIS (digital mapping) interface that could be applied to:

- assess the availability, withdrawals, losses and uses of the water resources
- formulate alternative development scenarios for water resources and demand/use at various planning horizons
- perform the balancing of resources versus demands for the recent past as well as for the alternative development options and
- identify technical and operational options in order to bridge the gap between resources and demands.

The Digital Planning Tools have been developed under MS-Access 2000 in VBA (Visual basic for Applications). The Digital Planning Tools had a modular structure and the software code was made open to the IT personnel in the Ministry. This should allow future modifications and extensions with the Ministry's own resources.

The Digital Planning Tools were also meant to be used to monitor and analyse the present water management situation and assess water resources and demand projections on a continuous basis. Furthermore, they should assist in evaluating reasonable options and strategies to reverse water imbalances and in managing and developing Jordan's water resources.

Shortcomings of the Technical Design

The outline of the technical structure of the NWMP gives a feeling for the ambition of the undertaking and its interlinkages with institutional challenges. MWI and GTZ were looking to establish a light-house project at international level. The technical development posed its own challenges. GTZ reported in 2004 in a corporate publication: "As with any software development, checking the functionality of the developed software took much more time than expected. Bugs occurred in the developed modules as well as in the WIS database and this hampered the production of reason-

able outputs. We were prone to becoming caught up in software development and in data management issues." (GTZ 2004, p. 18).

Overambitious technical design.

Unfortunately, the problems with software development were never completely resolved and the digital NWMP never became fully functional. Key problems were the balancing and allocation modules, which were only useable for MWI with constant support of international IT experts. These international experts played a major role in the whole development process. While the idea of the NWMP included training of national staff and finally handing over of responsibilities to MWI, the Ministry was at no time able to independently handle, let alone update the NWMP. This dependence on an international consulting company that tailor-made the NWMP software finally led GTZ and MWI to a system change in 2008 and use another software for national water master planning (the system WEAP, *see chapter 1.7.1*).

1.4.2 Institutional and political dimensions of the NWMP

Institutionalization of NWMP

Beside the technical difficulties, institutionalization was another challenge for the NWMP. GTZ had identified this as a key topic to be addressed through their support. A major success was the establishment of a NWMP Directorate within MWI in 2001. The original staffing was three persons. A continuous growth was expected over the next years, which, however, did not realize. While GTZ supported the development of internal process and trained the available staff, the number of personnel remained at the same level until 2008. In 2009, a project progress review found even decreasing capacities on MWI-side for institutionalization of the NWMP.

Successful institutionalization within MWI, but challenges with inter-agency exchange.

A key challenge at institutional level was the collaboration of different institutions in the water sector. The NWMP required data from different stakeholders, mainly WAJ and JVA. In order to facilitate data exchange, a unified coding compulsory for both water authorities was under development, but became never operational. This process was coordinated by an inter-agency Working Group on Standardization of Data and Information Flows. This Working Group aimed at standardizing and harmonizing the MWI, WAJ and JVA database structures and documentation systems. The digital NWMP served as a justification and a forum to tackle this issue for the first time in Jordan. The Working Group addressed important problems

in five task forces with the support of the NWMP team. Although major technical problems had been resolved, a full and timely data flow between the institutions was not established and is still not established until today.

Political ambitions of NWMP

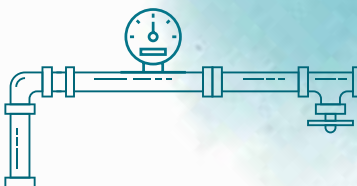
Linking NWMP to investment planning did not succeed.

The difficulties in coordinating data transmission between water sector institutions speak volumes about the challenges of integrated planning in Jordan. One aspect of the NWMP was to increase MWI's steering competency in the water sector vis-à-vis the other two major sector institutions WAJ and JVA. The idea was to link the NWMP to investment planning. MWI with the support of GTZ developed criteria for project design and connected the NWMP Directorate to WAJ's units responsible for project planning. A Project Information System was developed to standardize the institutional interplay in project planning. However, these procedures and tools were only partially used. It remained one of the key weaknesses of the NWMP that it never had the desired impact on investment decisions.

High political ambitions beyond the water sector.

The ambitions of the NWMP went even beyond the water sector. The NWMP was designed to mainstream water into all development planning and make the water sector institutions (especially MWI) effective guardians of the country's most precious resource. The vision was to establish procedures for a "Water Impact Assessment", which would give MWI a veto right on development projects if a major negative impact on the water resources was found. However, such procedure remained at a conceptual stage and the required changes in the legal framework never materialized.

In 2004, the digital NWMP was launched publicly during the International Water Demand Conference by the then Minister of Water and Irrigation. Through the publication of a series of brochures, workshops, a short film and the posting of the summary NWMP on the MWI's website, the project also sought to bring the findings and recommendations of the NWMP to the attention of all stakeholders in the water sector and the interested public. GTZ supported a series of trainings to raise awareness for the role of the NWMP in development planning. However, due to the lack of a legal framework, which would oblige stakeholder outside the water sector to take the NWMP-results into consideration, these efforts did not lead to tangible outcomes.



1.4.3 Recommendations of the NWMP

Recommendations were based on the policy guidelines from the National Water Policy of 1997.

Based on the analysis of available resources and current abstraction, the 2004 NWMP identified a number of strategies that were recommended to address the current imbalance between water use and available water resources. In order to reduce the water supply deficit and to secure adequate (quantity and quality) long-term water supply for all uses, three generic options were mentioned:

- increase available water resources
- improve water use efficiency
- decrease water demand.

Accordingly, policy adjustments, development strategies and action plans were required by the NWMP. The principles governing the recommendations of the NWMP all originated from the Water Strategy and Policies of the MWI approved in 1997. The most important of the principles enumerated in the NWMP were:

- first priority to drinking water, then tourism, industry and irrigation
- assurance of a minimum of 100 litre per capita and day of water supply to all citizens, independently of their place of residence
- full reuse of all treated wastewater
- mainstreaming of demand management in all planning and operations
- reducing the extraction of renewable groundwater to sustainable levels
- increasing efficiency of management and operations.

Based on these principles using the allocation and balancing routines of the NWMP software, five recommendations were developed:

- **Network rehabilitation:** It was expected that until 2020, the unaccounted water (standing at 50% in 2004) could be halved through technical interventions in water networks. This was supposed to save 100 MCM per year (and effectively increase the available water resources by this amount).

- **Reclaimed water:** It was recommended to extend the treatment of wastewater and its use in agriculture to replace freshwater. This would increase the available water resources in Jordan and corresponds to the activities in another GTZ project *(see chapter 4)*.

- **Desalination:** It is recommended to further explore desalination of seawater as a long-term solution to reduce the abstraction of (non-renewable) groundwater. This is also a way to increase the available water resources, though at relatively high cost.

- **Environmental hazards:** As water resources are very scarce in Jordan, pollution needs to be avoided strictly. The NWMP recommends to implement (procedures for) Environmental Impact Assessments for development projects and to establish ground-water protection zones to avoid pollution of (susceptible) aquifers.

- **Monitoring water resources:** The NWMP depends on reliable data to produce useful results. Data quality and the sharing of information between the stakeholders has been identified as a challenge in the process of developing the NWMP. Therefore, the continuous monitoring of all water resources (quantity and quality) is recommended for the future.

Recommendations of the 2004 NWMP remain focal areas of German support until today.

These broad recommendations are very similar to what was recommended in the 1977 NWMP. Apart from desalination, these topics remain key pillars in the German support to the Jordanian water sector until today.

1.4.4 Results and limitations

While the digital NWMP was a very meaningful and innovative approach, it never lived up to the high expectations. It succeeded in producing a comprehensive analysis of the status quo in 2004, but it failed to become a regularly updated system to support decision-making. Key results of the digital NWMP included the following aspects.

Increasing transparency and rescuing "data treasures"

Before the NWMP, information required for water management was kept highly confidential by the respective authorities. This has improved considerably, though not to the level desired and necessary for sound national water master planning.

Considerable achievements are overshadowed by exaggerated expectations.

A lot of data and information in the water sector was stored on paper or even only in the heads of sector experts. The NWMP exercise helped to digitize data treasures and to create a solid information base to which decision-making could refer.

Technical weaknesses and challenges of Human Resources

The NWMP software never reached a state of full functionality. Especially the software modules for allocation and balancing never reached full functionality. Updating of the software was only possible for international experts, not for MWI staff. From today's perspective, the software and database design seem inadequate as it overstretched the capacities of MWI by far. These capacities were meant to be developed through the technical cooperation. However, the high technical requirements of the software and the available skill levels in the MWI never matched. The establishment of the NWMP Directorate was a big success in terms of institutionalization of the NWMP within MWI. But it could only be a first step and further steps in building up the capacities of this Directorate would have been necessary. Instead, the number of staff fluctuated at a low level and repeatedly, qualified people could not be replaced adequately in time.

NWMP-tools never embedded within the Jordanian system.

1.5 2004 – 2008: Continued support to National Water Master Planning

After 2004, GTZ continued to support the NWMP and worked together with MWI on eradicating the technical bugs and increasing the use of the instrument. In parallel, GTZ supported the updating of the 1997 National Water Strategy. The new framework document for Jordan's water sector, the Jordanian Strategy "Water for Life", was approved in 2008 for a period until 2022 *(see chapter 3.3.2)*.

1.5.1 Operationalization and Technical Development

Improving the inter-agency exchange.

After the very supportive era until 2005, political support for the NWMP was reduced from MWI's leadership. Especially the crucial connection of NWMP to budget and investment planning was stopped completely until summer 2006 due to the character of these tasks as sovereign responsibilities. GTZ had developed an *Evaluation Tool for Investment Planning* (ETIP) that supported the assessment of planned projects and its evaluation based on the principles derived from the National Water Policy. The outcome of this process was meant to be discussed in an inter-agency committee on water information systems (the "Wise Committee"), where decision-makers from different departments of MWI, WAJ and JVA were supposed to meet. However, nor the ETIP neither the Wise Committee became operational. The final evaluation of the GTZ-project "Strengthening the Steering

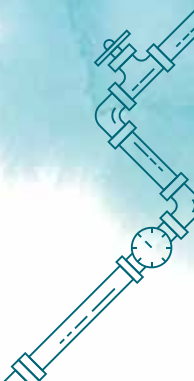
Competencies in the Water Sector" of 2006 stated that the resistance from within MWI expresses the opposition of conservative forces trying to hamper transparency and modernization of processes in the sector. After a shift in the upper management of MWI in 2006, GTZ restarted its support for the use of the Project Information System, a software tool coupled to the NWMP allowing to assess planning decisions with regard to their impact on the water resources.

Progress in digitization of historic data.

From 2004 to 2008, GTZ supported the further technical development of the NWMP software. Until 2006, 68% of all historic data on water quality, wastewater quantities and qualities and groundwater production were digitalized and transferred into the WIS. GIS as a decision support tool became another field of technical support for GTZ. The MWI-GIS committee (a working group within MWI) was supported and GTZ accompanied the technical improvements (e.g. establishment of a unified GIS-server for the Ministry) by organizational development. User needs were assessed and product development streamlined accordingly.

Technical and institutional challenges remained.

The goal for GTZ's support until 2008 was that allocations between the sub-sectors are taken based on the recommendations and models from the NWMP. On operational level, this required a full technical operationalization (i.e. MWI being able to produce a yearly water balance using NWMP-tools and WIS) as well as a full institutionalization of the NWMP (i.e. an institutional connection between NWMP and investment planning). These objectives were not achieved due to inherent problems with the functionality of the software and due to resistance within the partner system. These two complexes of challenges had reinforcing effects on each other. It is difficult from today's perspective to identify the one decisive factor. Clearly, the software side is more within GTZ's realm of influence and in 2008, GTZ pulled the emergency brake. A joint decision between MWI and GTZ was taken to stop support for the NWMP-software and start with a completely new software *(see chapter 1.7.1 below)*.



1.5.2 Jordan Water Strategy of 2008

New water strategy connected water to socio-economic development.

In parallel to the further development of digital planning tools, GTZ supported MWI in the updating of the 1997 National Water Strategy. The new Jordan Water Strategy covered the years from 2008 to 2022 and elevated water from a sector concern to a national preoccupation and priority. This shift was mainly driven by the publication of the ambitious National Agenda (2005) – Jordan's first comprehensive action plan for reform across sectors with binding milestones – which recognized the strategic importance of the water sector. The National Agenda recognized that water scarcity can impede socio-economic growth and hence identified, as a priority, the need to upgrade water infrastructure (Yorke 2013, p. 40). The Jordan Water Strategy 2008–2022 proposed initiatives echoing those of the National Agenda. It aimed to close the water deficit by 2022 through large-scale infrastructure measures and through promoting efficiency in the sector. The main steps to achieve these are the following (MWI 2008, p. 1–2):

- an efficient and effective institutional reform
- a legally binding principle for water sector management based on the National Water Master Plan and the National Water Law
- a drastic reduction in the exploitation of the groundwater
- efficient use of water resources
- implementation of the Disi water conveyance and the Red-Sea-Dead-Sea projects
- a cap on irrigation water demand
- appropriate water tariffs and incentives will be introduced in order to promote water efficiency in irrigation and higher economic returns for irrigated agricultural products.

Two-fold strategy: augmentation of available resources and managing demand.

These topics expressed a balance between augmentation of available water resources and measures to reduce water demand. In this sense, it is a continuation and updating of the 1997 document. The dominant opinion by the time was that instruments to implement the ambitious political guidelines were still in its infancy and needed more time to have an impact. This included for instance the reduction of groundwater abstraction through better enforcement, a reduction of subsidies for irrigation water and an increased private sector participation in service delivery. Based on the recommendations of the 2008 Strategy, which were fully in line with overall objectives of the *German Development Cooperation* (DC), GTZ was encouraged to continue its support for the NWMP. The long-term objective for the

NWMP was formulated in the Institutional Reform Goal No. 9 of the Jordan Water Strategy (ibid, p. 8–8): The National Water Master Plan is institutionalized representing the binding strategic management instrument of the Water Sector [in 2022].

1.6 Since 2008: Planning in an uncertain environment

Shift of technical systems towards WEAP.

The afore-mentioned technical problems with the NWMP software led MWI and GTZ to the conclusion that the software was too complicated and not adequate, given the limited human resources of MWI. The balancing and allocation modules of the NWMP software remained dysfunctional leading MWI and GTZ to the conclusion that a system change would be the only solution. This decision was taken in 2008. However, there was a transition period when the shift to the new system was organized. With the influx of Syrian refugees into Jordan starting in 2011, the framework conditions in the water sector changed overnight with a growing demand for domestic water and a new population structure in the North of Jordan. The topic of master planning lost priority in this process and the goal to balance demand and resources became more utopic than ever. However, GTZ's support to master planning and strategy defining is ongoing until now, with the new National Water Strategy of 2016 being the most relevant outcome.

1.6.1 WEAP as new Software Tool for National Water Master Planning

Proven international system introduced that was used in the Middle East already.

The *Water Evaluation and Planning* (WEAP) software is a *Decision Support System* (DSS) designed by the Stockholm Environment Institute in 1988 to support water planning. It balances water supplies generated at watershed scale with multiple water demands and environmental requirements. The system's graphical user interface supports the construction of a network representation of a particular water system and facilitates water management dialogues organized around scenario development and evaluation. As a database, WEAP provides a system for maintaining water demand and supply information. As a forecasting tool, WEAP can simulate water demand, supply, flows, storage, pollution impacts, treatment and discharge scenarios. As a policy analysis tool, WEAP can be used to evaluate water development and management options taking account of multiple and competing uses of water. The level of detail may be customized to meet the

requirements of a particular scale of analysis and to reflect the limits imposed by the availability of data.

WEAP has proven to serve as a very useful software tool for water planning in more than 50 watersheds around the world; both in the context of industrialized and developing countries. It is a proprietary system, with additional training and support packages being available through the editor. The software was already used in the Middle East with German support through a project implemented by BGR with the *Arab Centre for the Studies of Arid Zones and Drylands* (ACSAD). WEAP was promoted in the region through ACSAD since 2004. The tool was used for small-scale modelling in different Arab countries, including Jordan. The experiences from these pilot models supported the introduction of the software as main instrument for national-level planning in Jordan.

DSS as an instrument that benefit other GTZ areas of intervention.

The direct objective of GTZ's support was to establish first water balances at basin and governorate level and later on countrywide. The linking of the different units within MWI, WAJ and JVA that produce or use data remained a key intervention area of the water programme. The goal was to ensure a timely and standardized flow of all relevant data to both WIS and WEAP.

An important element of GTZ's support was to link the support to data management and national water planning to other areas of intervention of the GTZ water programme. The WEAP model for Azraq basin was together with Amman-Zarqa the first to be developed. The Azraq Basin Model was meant to be used in the Highland Water Forum as an instrument to raise awareness and to increase the understanding of stakeholders about the effects of uncontrolled groundwater abstraction *(see chapter 3)*. However, due to delays in the development of the model, this did not materialize. In the EU-funded project "Improved Water Security for Low-Income Rural and Urban Communities" implemented by GIZ between 2012 and 2014, the modelling efforts were extended to the North of Jordan. In this project, a hydrological model for the Yarmouk basin was developed.

1.6.2 Further Decision support tools coupled to WEAP

Coupling of Surface Water and Groundwater Modelling

One of the advantages of WEAP is the possibility for dynamic links to

other models and programmes. One of these programmes is MODFLOW, an internationally known three-dimensional model for groundwater flows developed by the US Geological Survey. This system is of particular relevance to Jordan as groundwater is the most important water source within the country. Germany's BGR is working since the 1990s on groundwater modelling in Jordan using MODFLOW. The linkage between the two systems reduces the uncertainty of WEAP's scenarios.

WEAP could be linked to other important software tools.

Optimizing the economic benefits of water

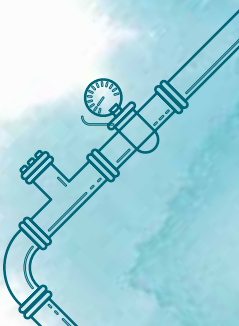
Another system that could be coupled to WEAP is the *Multi-Year Water Al-location System* (MYWAS). MYWAS is an economics-based system (developed jointly by scientists from Israel, Jordan and Palestine in the 1990s, which optimizes the benefits to be achieved from water subject to the policies and values specified by the user. It focuses on the value of water and guides decisions as to competing uses. It is therefore one step further than the previously discussed ETIP, which only looked on particular water projects. With MYWAS, the user can generate a hydro-economic model of the system (i.e. Jordan's water network and water use structures). This allows to base sub-sector allocation decisions on very detailed economic analysis. However, soon GTZ/GIZ and MWI realized that to implement MYWAS would be too ambitious considering the required economic data. The economic module of WEAP was considered to be sufficient for the Jordanian circumstances.

Facilitating Reporting

A much handier tool was developed with the support of GTZ recently: Reporter facilitates the extraction of particular types of data and their output in standardized forms, such as charts and tables. This is a step to ensure a certain level of quality of reporting as it eases the use of WEAP. Especially new staff of MWI can extract data from WEAP through Reporter without having undergone extensive training. Given the high staff turnover in Jordanian institutions, this is a very useful tool.

1.6.3 Results and limitations

The switch from the tailor-made NWMP-software to WEAP resolved most of the technical challenges that hampered the use of the planning software before 2008. However, this transition took time, and once the first models from WEAP were available, the refugee crisis started. The crisis led to a shift



Framework conditions changed and the expectations from national water master planning have been reduced.

of priorities of the water sector institutions to immediate water supply solutions and pushed longterm water planning in the background. Many of the recommendations from the 2004 NWMP became obsolete in the reality of the Jordanian water sector. Reducing groundwater abstraction was not realistic anymore and demand management through increasing water prices was out of discussion after the Arab spring. However, on demand of MWI, GIZ continued its technical support to the development of the planning tools. Today, WEAP is used in MWI, but to a limited extent. An evaluation in 2015 found that the operationalization of WEAP within MWI is close to be finalized and that the system is currently used for data collection. Currently, no scenario development is taking place and the system is not used for decision-making. After years of training, MWI still lacks capacity in modelling and scenario development. Brain drain of qualified people remains a major challenge in this regard.

Water balances are available.

Another problem related to the changed framework conditions is the volatility of political backing from MWI's leadership. While the importance of WEAP and of master planning in general was regularly confirmed, in the past years no clear guidance was given in which way the decision-support tools were meant to be used. Therefore, the technical development was ongoing with GIZ's support, but the prospect for actual use in decision-making was and is rather low.

Therefore, the key result achieved with WEAP are the water balances for each governorate and countrywide, which are now updated by MWI. This gives the water management institutions a close-to-real-time overview on resources and demand – on the condition that data entry and transfer take place as foreseen. Unfortunately, the cooperation of WAJ and MWI on data management remains a challenge until today. WAJ staff is responsible for inserting data on groundwater abstraction at government wells. This data is crucial for the water balances and hence for MWI producing reliable information. If the input of information in the WIS is delayed – as it happens regularly in reality – the establishment of water balances, which are meant to be the basis of allocation decisions, is delayed as well.

1.6.4 National Water Strategy of 2016

The refugee crisis required a change of the political framework for the sector.

The influx of refugees and the related population growth overtook the objectives and activities outlined in the 2008 Jordan Water Strategy. Therefore, MWI decided that an update is required which would then allow to incorporate new topics that became more prominent in recent years. In light of these developments and with support of GIZ, the new national water Strategy has been developed. This new strategy is valid from 2016 to 2025 and aligned to the National Agenda is the base document and is complemented by a set of sub-sector policies. These policies address particular aspects in detail.

There are eight subsector policies:

- Water Demand Management Policy
- Energy Efficiency and Renewable Energy in the water sector Policy
- Water Substitution and Re-Use Policy
- Water Reallocation Policy
- Surface Water Utilization Policy
- Groundwater Sustainability Policy
- Climate Change Policy for a Resilient Water Sector
- Decentralized Wastewater Management Policy.

The development of these policies was also supported by GIZ. Furthermore, there is the water sector Capital Investment Plan, which outlines to implement the principles from the Strategy and the Policies. In addition, an action plan to reduce water sector losses is in place and under implementation, complementing the target set out in the Strategy and Policies.

The water deficit is accepted as a fact by now.

The Strategy includes important provisions for crucial topics that are going to shape the water sector in the future, such as climate change and the water-energy-food nexus. However, the topic of overuse of resources is less prominent in the main document than it used to be in the previous Strategies of 2008 and 1997. It seems that the objectives of sustainability and balancing supply and demand were pushed back in sector priorities. The focus is on resilience of sector institutions (i.e. providing professional services and surviving economically) and ensuring supply of water to the growing population). The water deficit is still mentioned, but the sector seems to be more at ease with it, as all previous attempts to counterbalance have not succeeded.

1.7 Outcomes of GIZ-Support to National Water Master Planning

Relevant results, but Jordan's water deficit is bigger than ever.

GIZ supported national water master planning in Jordan in the late 1970s and then again constantly in the last 20 years. Compared to GTZ/GIZ's own objectives, this support clearly lacks sustainability. On the upside, one can note that GTZ/GIZ's support has paved the way to introduce treated wastewater as an accepted resource for irrigated agriculture. In 2016, treated wastewater makes up about 16% of all available resources in Jordan. The NWMP was crucial to ignite discussions about reallocation between sectors. This saved considerable amounts of freshwater for other purposes, especially domestic water supply. Furthermore, WEAP is operational at a basic level by now and MWI is able to follow up developments in the water sector with very little time delay. There are, however, considerable downsides to GTZ/GIZ's support to national water master planning.

1.7.1 Factors explaining shortcomings

Population growth and urban development are faster than any planning attempt.

Rapid change of Framework Conditions

The population development in Jordan led to a rapid increase of water demand for domestic use. In parallel, Jordan has evolved from a mainly agriculture-based developing country to a service-based middle-income country. This has shifted the geographical distribution of demand to the urban centres and doubled the overall water demand over the past 40 years. Nevertheless, agricultural water use remains high with over 50% of overall water consumption. The influx of refugees since 2011 has added a new dimension to this process, especially with regard to the speed of urban development. The concept of sustainable water use, i.e. a reduction of demand to the level of the available renewable water resources became increasingly obsolete in the Jordanian discussions. The urgent need to supply water to the growing population was dominating the sector in the last years. Therefore, it appears that Government's answer to the scarcity is rather in megaprojects that will increase the supply than in difficult demand management interventions. This reduces the relevance of national water master planning in the sense GIZ understands it.

Overestimation of MWI capacities and MWI's Ability to Build Up Capacities

When GIZ started to institutionalize the NWMP within MWI, development of human resources was a major element of support. However, GTZ/

GIZ's expectations of how much personnel MWI could make available for national water master planning were different from what happened in reality. MWI was never able to provide the required amount of people with the required qualifications. Brain drain of newly trained MWI staff added to the problem. It is a basic principle of international development cooperation that the technical systems supported need to take into account the existing capacities of the partner institutions. This principle was not adhered to in GIZ's support to national water master planning.

Institutional weakness of MWI and brain drain as key problems.

Weak cooperation between Water Sector Institutions

Another aspect of institutionalization is the improvement of relations between water sector institutions, mainly between WAJ (responsible for most (public) water abstraction) and MWI (responsible for monitoring of water resources). The data flow between these organizations seems to be a technical issue, but it has political implications related to the power distribution in the sector. GIZ's approach to address the issue from the technical side through standardization of data sharing protocols etc. appears meaningful, but it failed.

Cooperation between sector institutions remains weak.

Overambitious Political Goals of NWMP

The ambitions of the 2004 NWMP went even beyond the water sector. The vision of a "water impact assessment" conducted by MWI made sense from a water sector perspective, but it neglected the powerplay between sectors in Jordan. The political buy-in into the NWMP was not ensured even in the water sector *(see above)*, therefore the attempt to mainstream water aspects into development was doomed from the beginning.

Quality of Software Development and Supervision of Development through GIZ

Another issue that relates more to GTZ/GIZ's homework is the quality of the technical support to MWI. The original NWMP software was under development for about 11 years but had to be finally abandoned because it never became fully functional. This is disappointing and questions GTZ/GIZ's ability to supervise the development of complex software products. The shift to a well-known international product with an established support structure was a painful but necessary move. However, the challenge remains that the full use of the WEAP software requires a high-level skill set, which is rare at MWI.

1.7.2 The Missing Link from strategy to implementation

GTZ/GIZ successfully supported the development of strategies and tools for implementation

The overall rational for national water master planning over many years was to reduce Jordan's water deficit and to put the water sector on a development path towards sustainability, understood as a balance between available resources and consumption. This objective is not achievable in the foreseeable future given the current size of the deficit and the recent population development. While Water Strategies and Policies have reflected a shift of emphasis from a supply-oriented approach towards demand management of precious water resources, the Government had been slow to advance beyond commitment towards implementing significant demand management reforms to protect depleting groundwater reserves, cut back on fresh water used for irrigated agriculture, raise and restructure tariffs, reduce non-revenue water and introduce market-oriented reforms" (Yorke 2013, p. 38). Therefore, GTZ/GIZ was successful in supporting the development of these political guidelines, but it failed in supporting their implementation. "Water reformers, keen to push through water demand management, are present throughout the sector. […] Although some important steps towards reform have been taken, results to date have been disappointing, amounting, some say, to 'tinkering at the edges' (ibid, p. 35). The previously provided analysis suggests that the answers to the problems of the Jordanian water sector are to find outside of the sector. Therefore, they go beyond the scope of water projects and programmes. While the Jordanian government agrees on the relevance of national water sector planning, the overarching objective of the German partners (increasing sustainability in the sector) seems to be outdated. Therefore, a political agreement on new joint sector objectives is necessary.

Implementation on the ground did not take place.

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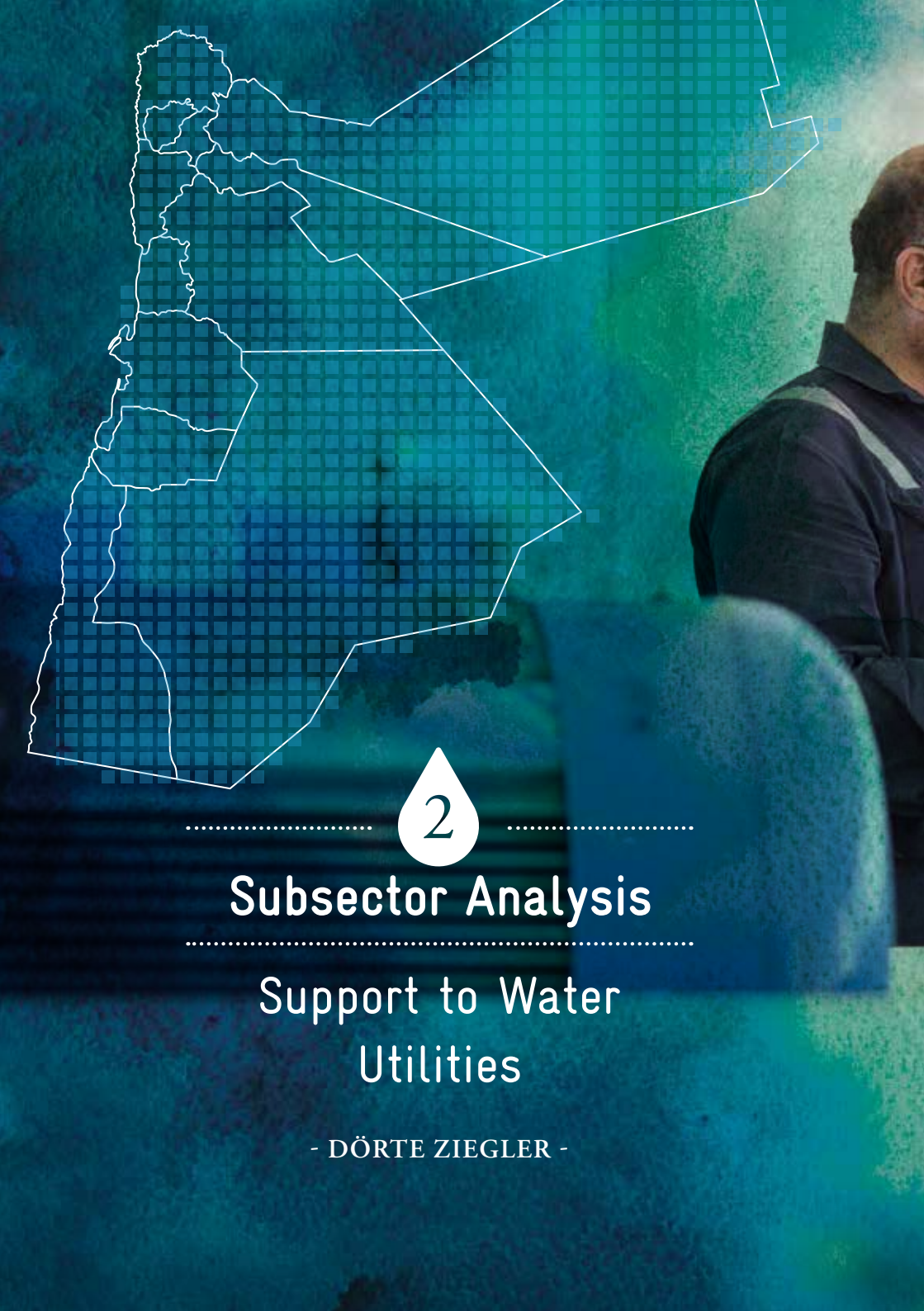


2

Subsector Analysis

Support to Water Utilities

- DÖRTE ZIEGLER -

2.0 Support to Water Utilities | Dörte Ziegler

2.1 Challenges for Water Supply in Jordan in 1991 – 1993

Insufficient water supply characterized water-scarce Jordan 25 years ago.

In the first GTZ project dealing with water supply, the challenges of Jordan were described as follows: "Water supply in Jordan regarding quality and quantity is insufficient, especially for the 1.6 M people in Amman." (GTZ 1991) "Insufficient" refers to the bad state of the pipeline network, to water dissipation and wastefulness, but also to the management of Jordan's major institution, the WAJ, and to a perceived high bureaucracy.

In 1991, the causes for this insufficient water supply were seen in the following, often interlinked factors:

- competition for water between irrigation and water supply in a situation of high water scarcity
- high bureaucracy due to laws and budget restrictions for the public sector, causing delays in and underfinancing of investment processes
- high physical and commercial water losses
- qualitatively bad state of the tertiary network and household connections
- major investments in technical equipment with a focus on new water resources, transport and reservoirs, resulting in a lack of budgets and resources for maintenance and rehabilitation and more efficient water supply, and on the other hand in increasing costs for water
- partially inefficient management of the WAJ that is responsible for Water Supply
- lack of economic capacities within WAJ
- lack of technical competence of the personnel of the utilities
- human resource management with poor performance orientation
- data situation that is often not reliable or incomplete
- insufficient or delayed tariff adaptations, and
- high debts of WAJ.

The gap between water demand and renewable water resources increases since more than 25 years.

Promoted by population and economic growth, but also aggravated by inefficient water supply, the gap between available renewable water resources and water demand was already then increasing at an alarming rate

(*see also Table 2.1)*. It was also observed that supply deficits impacted particularly on the weaker parts of society. This insufficient and socially unjust water supply increased the danger of social unrest.

Year	2005	2010	2015
Population (M)	5.3[1]	6.2[1]	7.6[2]
Domestic Water Supply (MCM)	291[3]	352[3]	440[3]
Domestic water supply (l/c/d)	129[3]	147[3]	126[3]
Treated Wastewater (MCM)	99[3]	110[3]	147[3]
Non-Revenue Water	45%[3]	43%[3]	51,3%[3]
Running costs (O&M) without interests (JOD)		136[3]	245[3]

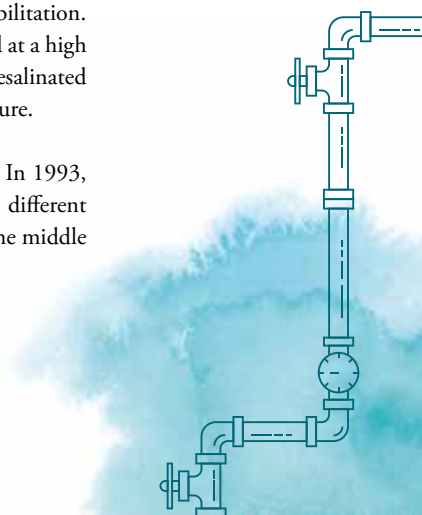
Table 2.1
Data on the Jordanian Water Sector

Sources:
1) World Bank 2016;
2) WHO/UNICEF JMP 2015; 3) MWI 2016

Looking at the alarming water scarcity in Jordan in 1991, it was expected that a business-as-usual approach for water supply would require WAJ to use fossil groundwater, with the affected aquifers then being damaged irreversibly. It was also projected that the debts of WAJ would increase; that the insufficient water supply for industry and tourism would have negative economic impacts; and that the increasing effort to treat brackish and/or sea water and to find new water resources would increase the costs of drinking water supply and decrease the resources for maintenance and rehabilitation. Since 2013, fossil groundwater from the Disi aquifer is being used at a high cost as drinking water in Amman and the middle governorates. Desalinated water from the Red Sea is planned to be exploited in the near future.

The water gap is closed with fossil groundwater, and soon with desalinated water.

Institutionally, WAJ was and still is responsible for water supply. In 1993, WAJ had several regional branches that were responsible for the different governorates of Jordan: four in the South (including Aqaba), in the middle (including Amman), and in the North respectively.



Wastewater services were not analysed explicitly at the time. Reasons were mixed:

1) Water supply services already proved to be a very vast field requiring support.
2) Since WAJ is responsible for both water and wastewater services, its reorganization was expected to also positively affect wastewater services, and
3) the BMZ had not yet explicitly stated that support for water supply would need to be linked to sanitation services.

The GTZ/GIZ is a long-term partner for improving Jordan's water supply services across the regions.

Timeline of German support to Water Supply

On behalf of the BMZ, GTZ has been requested to cooperate with the WAJ in 1991. The cooperation with WAJ started in March 1993 with the first project "Support to Utility Management of WAJ". The cooperation period described by interview partners dates back to 1994. This study therefore covers the period from 1993 to 2016, i.e. 24 years. The Jordanian-German cooperation on Water Utilities is continuing within the Water Resources Programme regarding Balqa, and with a project supporting the Yarmouk Water Company in the North of Jordan called "Strengthening the Resilience of Water Supply".

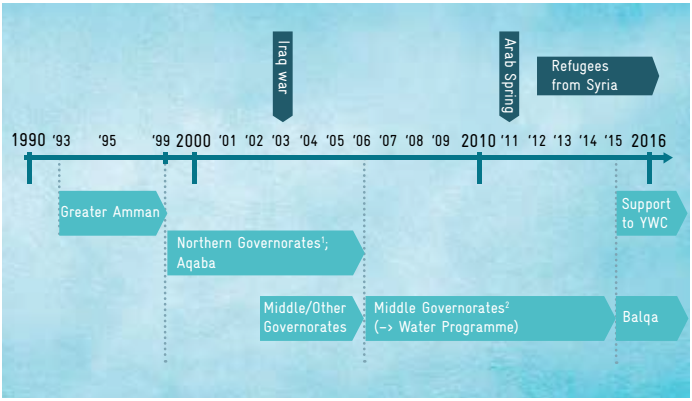


Figure 2.1
German Technical Cooperation related to Water Utilities from 1992 until 2016

Sources: own compilation

In total, there were eight subsequent GTZ/GIZ projects dealing with water utility management *(see Fig. 2.1)*. Since 2006, the support to water utilities became part of larger water resource programmes. In 2015, with increasing funds available for Jordan, the support to the North, i.e. the Yarmouk Water Company, restarted with a new project.

The German technical cooperation started with improving water supply in Amman, with an approach of decentralization, better customer information and accounting tools *(see Fig. 2.1)*. The support for Greater Amman ran from 1994 to 1999 and led to an international management contract from 1999 to 2007. In 2007, Amman's water company Miyahuna (Arabic for "our water") was established. Starting in 1999, the German technical cooperation's approach was transferred to the South to Aqaba and to the Northern Governorates. In 2002, the Middle Governorates were involved in the cooperation, with the support concentrating solely on the Middle Governorates from 2006 to 2015. Due to a large increase of funds for technical cooperation from 2012 to 2015, GIZ restarted the cooperation with the Yarmouk Water Company in the North. Also, the support to the middle governorate Balqa continues. The support to WAJ continues in different projects related to specific topics such as maintenance, wastewater management and sludge, and water and energy. Looking at the population served by these water utilities, the GTZ/ GIZ support has covered the majority of the Jordan population, even though the three Southern governorates Tafielah, Ma'an and Karak were not included. The population and water supply in those three governorates amounts to less than 10% of the country.

The GIZ/ GTZ support has covered Amman, the North, Aqaba, and the middle governorates

Due to the refugee crisis, other smaller projects related to water utilities are implemented in Jordan related to water utilities. They deal with better communication on water, with decentralized wastewater treatment, and with job creation in the water sector, but they were not analysed in this study.

Regarding the organization of the technical cooperation, the support developed from separate projects in the 90s to the first water programme starting in 2006, with additional single projects since the budget increases for Jordan.

Water utilities in Jordan are supported by multiple donor organizations, among them also KfW, the German development bank for investments. KfW and GTZ/GIZ therefore were working closely together regarding the transformation of water utilities. Between 2002 and 2009 the interlinkages of KfW and GIZ were formalized in two cooperation programmes. The organizations InWEnt and DED were also working with water utilities in Jordan. Both organizations were integrated into GIZ in 2011. BGR was not involved in water utility management but is supporting Jordan with groundwater management.

GTZ/GIZ is working in close cooperation with multiple donor organizations to improve water supply.

2.2 Transformation and decentralization of Water Utilities in Jordan

In response to the afore-mentioned challenges of water supply, the Jordanian Government embarked on a path of transforming the water supply sector. Steps of this transformation are therefore core objectives of the Jordanian-German cooperation with regard to water utilities. The utility management should move from WAJ to decentralized units that would operate on commercial principles. The intended impact was to reach more efficiency and to improve the service. To strengthen performance, the approach was also to promote the involvement of the private sector.

The Jordanian goal was to decentralize and commercialize the water supply sector.

The transformation process started with the *Amman Governorates Water Authority* (AGWA), continued with the Northern Governorates and Aqaba, and then included the middle governorates. The engagement resulted in the establishment of three water companies: Miyahuna, the *Aqaba Water Company* (AWC), and the *Yarmouk Water Company* (YWC).

The role of GTZ/GIZ was to support the MWI and WAJ in the many steps necessary for this transformation. The approach was to start with the WAJ unit for the governorate of Amman and to decentralize their management.

2.2.1 The Approach: Operation and Management Support to Water Utilities

OMS is the approach for improving the management and operation of the WAJ governorates. The OMS approach strives for better financial and technical efficiency, also through a decentralized administration and through involving the private sector.

The OMS approach included four topics:

- information management
- financial management
- customer management, and
- operation management *(Dorsch 2011).*

These four elements are inseparably linked among each other and hence were always applied together, with the aim of improving the operation and management at the decentralized utility level. They are described in the

following sub-chapters. OMS was first developed for Amman starting in 1994. Since 1999, OMS was transferred to Aqaba in the South and to the Northern governorates, and since 2006, to the middle governorates Balqa, Madaba and Zarqa. The outputs of OMS laid the basis for decentralized and commercialized water utilities.

OMS was a key approach for the transformation process.

The OMS-approach was tailored to the decentralized level of the utilities, but it also involved assistance to the national institutions MWI and WAJ. In those national institutions, it was important to support the enabling environment for decentralization and commercialization. For example, a decentralization concept was elaborated, tasks and responsibilities for decentral management were defined, tasks were delegated to decentral units, and a position paper on commercialization was developed by WAJ. With the first management contract in view for Amman, the establishment of a unit to manage this contract became necessary (e.g. GTZ 1998). Hence, the *Project Management Unit* (PMU) was established in 1999, with its foundation also being pushed by the World Bank and the European Investment Bank. The establishment of the PMU involved institutional changes including an adapted financing system of the PMU and the installation of processes for contract monitoring. The systems to be used by the PMU for monitoring the performance of the management contractors and the water companies were established with support from GTZ/GIZ. The PMU in its current set-up is still challenged with managing the complex contracts regarding the water sector.

OMS – Information Management

The objective of improved information management is to provide the utility with data on its operations, assets and customers. It aimed at introducing a GIS-based management within the utilities *(see Fig. 2.2)*.

Key elements included:

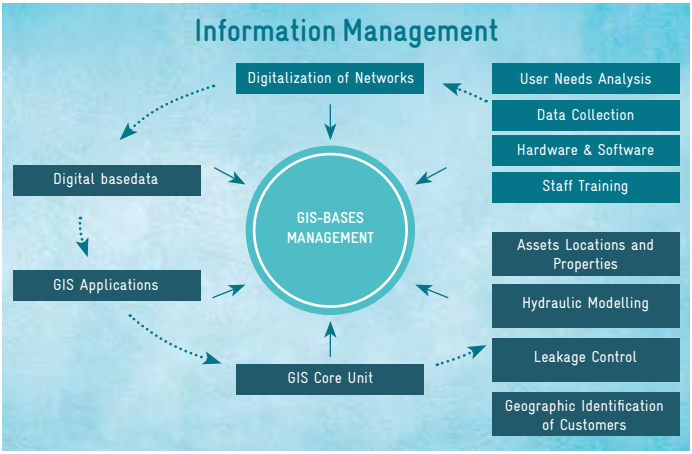
- hardware and software for GIS infrastructure
- data collection on networks and customers to be included into GIS applications
- institutional aspects such as a management unit for GIS & staff training.

OMS involves elements from contract management for better information and accounting.

The GIS system was supposed to be used for leakage control and hydraulic modelling, i.e. operations management. GIS is also linked to financial management because it is used for asset management, and through its

Figure 2.2
OMS - Information Management

Source:
Dorsch (2011)



customer data for customer management. Better information management improved the availability and reliability of data in water utilities. This improved information and transparency. The improved data laid the basis to restructure the sector and to involve the private sector through different forms of management contracts.

OMS – Financial Management

The objective of improved financial management is to increase the transparency about the costs and revenues of water supply. Knowing the real costs and revenues is a prerequisite for increasing the efficiency of a utility *(see Fig. 2.3)*.

Key elements of the OMS financial management include:

- Introduction of commercial accounting procedures and balance sheets, linked to introducing accounting sections, accounting standards and accounting systems. The accounting systems were also linked to the billing system.
- Financial reporting, mainly demonstrated by Profit and Loss Statements (P&L statements; Dorsch 2015 a, b, c). The Profit and Loss (P&L) statements also include Non-Revenue Water balances according to the methodology of the International Water Association.
- Restructuring of utilities into profit centres, i.e. decentral units that manage their own profits and losses with the goal of decreasing costs and improving revenues.

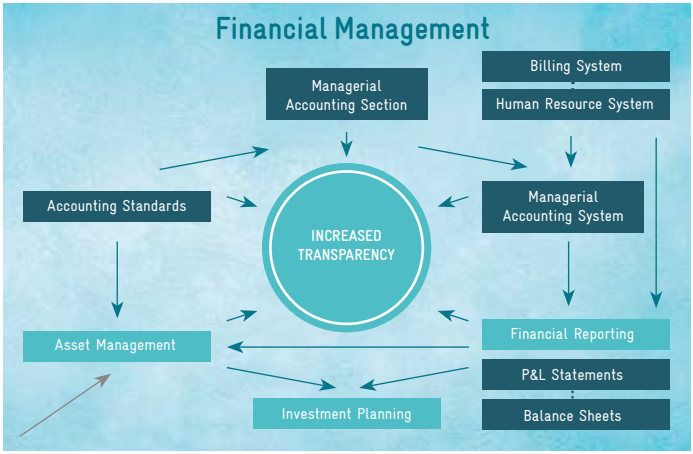


Figure 2.3
OMS – Financial Management

Source:
Dorsch (2011)

With better accounting and better financial reporting, asset management and investment planning would also be based on improved information. The P&L statements were the basis for all private sector contracts, i.e. the management contracts, the management consultant concept in the North and the Micro-PSP contracts. The P&L statements also contributed to the understanding of the major cost factors of water supply in Jordan including the high costs for energy. They contain key information necessary for decisions to improve the economic situation in the sector. Decisions to raise water prices and to adapt the utility management are partly based on the information from the P&L statements.

New IT and GIS systems supported improved accounting and strategic reduction of costs.

OMS – Customer Management

Improving customer management is one of the key elements to improving a water utilities' billing system and to improve its revenues. Customer management also contributes to better relations with the utilities´ customers.

The major element of OMS related to improved customer management were several *Comprehensive Subscriber Surveys* (CSS) that were carried out for all WAJ units that were supported by GTZ. With those CSS, the addresses and floors of all subscribers were entered into a GIS-based database. Altogether, there were nine CSS carried out with the support of GTZ: the first in Amman, then one in Aqaba in the South and Irbid in the North, followed by the remaining three northern governorates, and then by the three middle governorates. Another CSS was managed by KfW and Dorsch for Karak. All the CSS were only possible with substantial partner contri-

Nine surveys on subscribers improved billing and increased revenues.

butions – the WAJ financed the teams, the software and the vehicles necessary for the CSS.

The introduction of the CSS did not only involve the GIS software, but also software systems linked to accounting and billing. Based on the CSS, the utilities' billing system could be improved. The bills are now issued at the doorstep with mobile devices. In Jordan, there is no possibility to issue the bills by mail. To adapt the former billing system, the business processes were analysed and adapted.

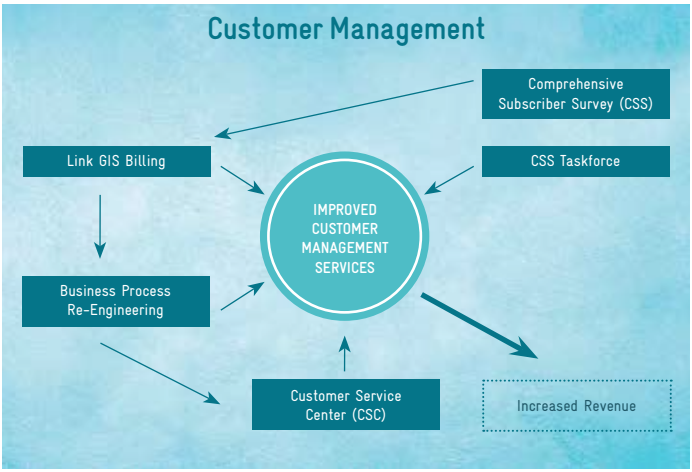


Figure 2.4
OMS - Customer Management

Source:
Dorsch (2011)

Overall, improving the customer management contributed to improved data and information, and improved billing systems. This was the basis to improve the revenues of the utilities and to reduce commercial losses. The linkages to information and financial management are therefore very strong.

Maintenance and repair services are key to improving operations management.

OMS – Operations Management

The objective of this OMS-element was to improve the technical operations of the utilities. The overarching goal was to improve the water pipeline networks through improving their maintenance and repair *(see Fig. 2.5).* This should reduce technical water losses and break-down times, and potentially improve the service quality for the customers.

Key aspects of operations management included:

- the introduction of IT systems such as GIS and other mostly open source software packages for pipeline mapping and hydraulic modelling
- better management of spare parts and maintenance equipment, also supported by the introduction of an open source software, the *Dorsch Consult Maintenance Management System* (DCMMS)
- introduction of innovations to reduce technical water losses such as the new *high-density Polypropylene* (HDPE) pipeline material standard (which is now, with ongoing rehabilitation of the networks, applied in about 99% of Amman's network) and pressure management
- support to improving leak repair, also by establishing leak repair teams
- improved analysis of the causes for water losses and non-revenue water through better data analysis, including the systematic use of the *International Water Association* (IWA) water balance.

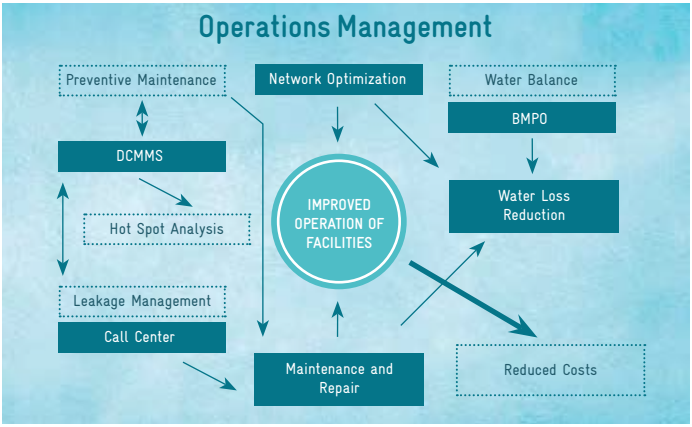


Figure 2.5
OMS - Operations Management

Source:
Dorsch (2011)

Operational management has succeeded in mapping pipeline systems and in introducing software packages such as DCMMS. Methods how to reduce physical water losses were successfully demonstrated in pilot areas. Also leak detection via customer information and better management of spare parts was improved. However, a well-maintained network and well managed water losses are still a challenge for water utilities. With limited staff and a lack of incentives to improve performance, leaks will remain high and repair quotas low. Preventive maintenance will also continue to be deficient. The support for improving maintenance in utilities is therefore still required.

Leak detection and repair is still a challenge for water utilities.

2.2.2 OMS – an all-inclusive or limited approach?

When comparing the OMS approach with methods to combat water losses and non-revenue water, it can be stated that OMS includes nearly all topics mentioned to reduce those water losses, from setting up water balances over improving customer databases, billing systems and data transfer up to improved maintenance and leakage repair *(see also Table 2.2).*

Table 2.2
Methods to combat Water Losses and Non-Revenue Water

Sources:
adapted from GIZ and WLR (2010) and Simbeye (2010)

General	Commercial Losses	Physical Losses
• Develop Water Loss Reduction Strategy	• Improve customer database and customer account management	• Improve leakage detection, also by active leakage control
• Set up Water Balance according to IWA	• Improve metering and data transfer: bulk meters, customer metering, meter accuracy testing, meter rotation & maintenance programmes, audit samples of suspect accounts	• Improve leakage repair (speed, quality, maintenance management – logistics, qualification of staff)
• Manage water losses by district metering areas (DMAs)	• Reduce unauthorized consumption (e.g. by in-spection to avoid bypasses and illegal connections; prepayment structures)	• Improve maintenance of pipelines
	• Improve billing system (e.g. computerized billing systems)	• Implement pressure management
	• Improve the collection rate	• Develop long-term rehabilitation strategy

However, the OMS approach is very technical. Institutional and organizational aspects such as water law, law enforcement, decentralization, tariff structures, and the need for a regulatory body are not explicitly included in the OMS approach. Neither are the change processes necessary for decentralized management and the involvement of the private sector described, even though they were part of the cooperation and support and partly described in separate publications (e.g. Dorsch 2012a, 2014).

There is also the critique that the OMS approach is partly not sustainable: The CSS were carried out as a one-time task, even though such an exercise requires an institutional continuity. Also, the capacities for preparing P&L statements for the middle governorates are not yet sufficient, and their preparation in 2015 required GIZ support.

The OMS approach is comprehensive, but underestimates institutional aspects.

OMS is therefore a very solid and comprehensive approach that was adequate to supporting Jordan's water sector. Nevertheless, based on the Jordan experiences, the concept would need to be adapted to also include institutional changes including contract management and regulatory functions.

2.2.3 1993 – 1999: Greater Amman

As explained before, the OMS-approach was implemented in nearly all regions of Jordan during 24 years. However, details of application and results differed according to the specific framework conditions. Those specifics include the time, the geographical and customer structure of the utility, the growing capacity of Jordanian consultancies, and political and financial aspects.

The OMS approach started for the area of Amman, covering all four aspects of OMS, i.e. the introduction of GIS systems and new accounting systems as well as comprehensive subscriber surveys. In parallel, WAJ was closely supported to decentralize the water utility management of Amman. Thanks to this support, the transformation out of WAJ to an independent water company was a successful process. It culminated in a management contract for the AGWA. The World Bank mentions that the preparation of the related management contract took a lot of time, but it was finally successful: The management contract of 1999 with the consortium LEMA was extended from three to an overall period of 7 years (World Bank 2016). In 2007, the Water Company Miyahuna (Arabic for "Our Water") was founded. Clearly, the approach of OMS has laid the basis for Amman's Management Contract.

As a result of the management contract, several performance indicators could be improved during the six-year contractual period: "Water supply coverage has risen from 90 percent to practically 100 percent; sewerage coverage has risen from 69 percent to slightly above 90 percent period; continuity of water supply under pressure has gone up from a daily

equivalent of < 4hrs/d on average to > 9hrs/d; and the share of water supply accounts with operational water meters rose dramatically up from about 55 percent in 2000 to practically 100 percent in 2005." (World Bank 2016)

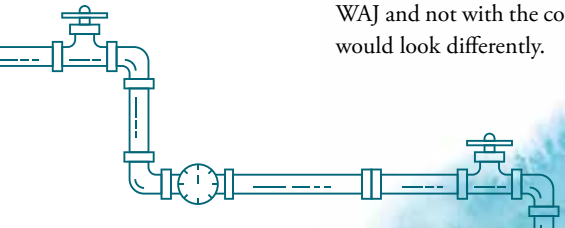
Amman is a success story for private sector particiption.

With the preparation by German technical cooperation, especially regarding the update on customer information, the consortium LEMA together with AG-WA could generate additional revenues of JOD 5–7 M. The basis of this success was a substantial reduction of the commercial water losses. There were several attempts to reduce not only commercial, but also physical water losses in Amman. For example, the amount of leaks has been studied in the late 90s, resulting in the figure of 80,000 leaks per year in Amman. The reasons for physical water losses were analysed, with the assessment that 60% of the leaks occur at the last 30 meters before the house connection. In a pilot area in Amman, household connections were improved in the 1990s, night flow analyses were carried out, and thus physical water losses reduced from 40% to 7%. In addition, a partnership with a German company VAG reduced physical water losses: In the district Ain Al Basha, the installation of pressure management could achieve a considerable reduction of physical water losses from 44 to 32% (Rothenberger 2009a; GIZ WLR 2010, p. 207f).

Other outputs of German technical cooperation include a strategic communication plan which serves as best practice for other utilities (see Barnes et al. 2012, p. 56–20ff).

GTZ/ GIZ were successful in reducing water losses and improving revenues, but costs for water supply are still rising.

Many elements of German technical cooperation are enduring today, such as the GIS system or the P&L statements. Miyahuna has achieved to cover 103% of their operating costs by their revenues in 2013 (KPI 2013). The positive story of Amman is underpinned by the fact that for two of the three middle governorates, management contracts have been signed with Miyahuna in 2014 and 2015. However, water supply in Amman is still limited to a few days per week or month, and both physical and commercial water losses are still high: non-revenue water was 40% in 2013. The attempts to reduce physical water losses could not be scaled up, and leakage rates are still high. The outlook for Miyahuna is challenging, since the costs for water supply in Jordan will rise under the current scenarios, while the revenues are difficult to increase. Also, the assets of Miyahuna are still with WAJ and not with the company. Should this change, the financial situation would look differently.



2.2.4 1999 – 2006: The South: Aqaba

Regarding Aqaba, the GTZ started the support in 1999. At the time, the staff and management of the WAJ unit responsible for Aqaba was considered to be open to change. They were interested in the support offered by OMS. The Aqaba unit was already at that time the only water authority with revenues surpassing the costs. The resulting transformation resulted in the founding of the AWC in 2004.

The AWC is regarded as a success. Aqaba has a positive profit and loss balance: revenues covered 134% of operating costs – this is the highest rate in Jordan. Non-revenue water rates are comparatively low with 26% in 2013, thus close to the official target of 25% (KPI 2013). The reasons are multifold: Aqaba has some large, financially strong customers and a concentrated territory. Also, the staff working in Aqaba is well qualified, e.g. in accounting, GIS and IT systems. The outlook for Aqaba is positive: the management of the company is considered to be in a good condition, backed by an economic situation that allows for investments and adequate salaries.

2.2.5 1999 – 2006 and since 2016: The Northern Governorates

The Northern Governorates were supported by GTZ/GIZ from 1999 to 2006. Technical cooperation stopped in 2006 – whereas financial cooperation from different institutions including the KfW continued. In 2016 with new funds from the BMZ, GIZ resumed the cooperation. Even though the approach of OMS was similar to Amman, the transformation process for the North proved to be more complex and involved more political interference.

As in Amman, the OMS approach in the North involved a decentralization process accompanied by OMS. This involved the introduction of accounting systems and of GIS systems, and four customer subscriber surveys in Mafraq, Ajloun, Jerash and Irbid. The formal decentralization was successful with the creation of the *Northern Governorates Water Authority* (NGWA) in 2001, only two years later than AGWA. Through OMS, the ground was prepared for outsourcing management tasks in 2003. However, no international consortium entered the bidding. This was partly due to the Gulf War that started in 2003, but probably also due to the more complex geographical setting of the Northern Governorates.

While Aqaba was successfully transformed to a water company, the Northern Governorates present a complex and much more challenging picture.

With GTZ support, the concept of a management contract to involve international companies was therefore adapted to involving a management consultant (Stoll 2007, p.5). The concept of the consultant is based on a service contract, whereas the management contract involves performance-based out-sourcing of management tasks. The company Severn Trent won the bidding in 2003. Due to different unresolved opinions between Severn Trent and WAJ, the contract was terminated by the Jordanian Government in 2005. GTZ stopped its support in 2006, concentrating on the middle governorates. KfW continued the support to NGWA. Six years later in 2011, the YWC was founded. Again, a management contract was tendered. Other than in 2003 international bidding now worked, and the contract was won by Veolia who supported Yarmouk Water Company from September 2011 to 2012 (Veolia 2013). Veolia was able to reach considerable improvements, based on the foundations laid by OMS (Veolia 2013). For example, the share of correct invoices could be increased from less than 50% to over 99%, and the coverage of meter readings was increased from 75 to 98% (Veolia 2013). Customer invoices issued at the door step were introduced. The total revenue was increased from JOD 20 M in 2011 to JOD 22 M in 2012.

Like the contract of the management consultant, the management contract with Veolia was also terminated in 2012, i.e. previous to the official end, due to unsolvable differences between the Jordanian and the French side. The Arab Spring influenced this situation – with staff in the North striking for salary rises and partly blocking the international staff of Veolia to enter the utility buildings.

In the North, GTZ interrupted the support between 2006 and 2015.

Nowadays, the YWC is struggling with very high operating costs (JOD 74 M in 2012, and JOD 18 M in 2013) and a lack of revenues from water bills. In 2013, operational cost recovery was only 70%; and non-revenue water rates were high with 46% (KPI 2013; CIP2016). Possible reasons for the difficult situation in the North are a comparatively large territory, high energy costs for pumping water across this territory, and the fact that the assets are with YWC and not with WAJ (other than Miyahuna where WAJ holds the assets). The capacities of the utility are not sufficient for all aspects of OMS. In addition, the relationship between YWC and WAJ is not easy, also due to the history of salary strikes. Partly due to the refugee influx in the North, GIZ resumed the support for YWC in 2015. The current cooperation focuses again on improving the commercial situation of the utility-resuming elements of OMS, and closely tailoring the support to the actual need of the utility.

2.2.6 Since 2002: Middle governorates

Various contract modalities for private sector participation were applied with mixed outcomes.

Based on the experiences from Amman, the North and Aqaba, the GTZ entered into supporting the middle governorates Balqa, Madaba and Zarqa to become decentralized, commercially operating units. The support started in cooperation with KfW in 2002 – where both the North and the Middle governorates were supported. From 2006 onwards, the middle governorates became the sole focus of technical cooperation with water utilities, again in close cooperation with KfW. As in Amman and the North, the OMS approach involved the installation and improvement of GIS and IT systems, the application of CSS and the installation of accounting systems to set up profit and loss statements. The first P & L statements were ready in 2008 for the year 2007.

The middle governorates were supported with OMS and local Micro-PSP contracts.

The private sector was involved since 2005, in this case with another new format called Micro-PSP contracts. The preparation of a management contract was not possible at the time, because the utilities were too small. In parallel, the Jordanian water sector had evolved, and it was possible to contract local companies such as Engicon for topics such as customer management and water loss reduction. The Micro-PSP model was defined as "private sector participation in operation, maintenance and management of selected business activities and smaller business units of WAJ, enabling local private companies to support commercialization and efficiency of service delivery in WAJ. It includes outsourcing of clearly identified functions/ business processes in O&M of water supply and wastewater disposal…" (Abu Shams and Kachel 2003, in Rothenberger 2009a). Examples for outsourced functions include billing and revenue collection; the replacement of sewerage connections or water service connections; leak repairs service; IT and customer management, customer surveys and GIS services; operation of special plants and equipment; vehicle repairs and maintenance (Rothenberger 2009a, p.21).

The Micro-PSP contracts involved many aspects: In Madaba, Engicon took over tasks such as improving water and wastewater revenue, reducing the amount of outstanding payments from customers, improving customer management efficiency, installing an IT-based customer management system, and developing the customer management organisation. The micro PSP approach of Madaba was reported to be very successful: The Company Engicon realized a doubling of revenues in three years (Rothenberger 2009a; Barnes et al. 2012, p. 48 – 13f). Net billed water increased by 75%

in the first year; net collections increased from JOD 0.9 M in 2005 to JOD 1.9 M in 2008; and NRW decreased from 45% to 35% due to a reduction of commercial losses. However, this success was later offset by increased physical losses.

The success factors of the PSP were performance-based pay guarantees for the contractor, and the political acceptability of the Micro-PSP approach since it did not entail selling government assets (Barnes et al. 2012). In light of the successes, WAJ prolonged the contract with Engicon – without any subsidies of donors. The visible short-term effects of Micro-PSPs increased the trust in the concept (Lutz et al 2009). The success of Madaba was transferred to Balqa where another Micro-PSP contract was prepared (PPR 2010), and also to Zarqa (Dorsch 2014). Altogether, there were 4 Micro-PSP contracts carried out, three by Engicon and one by Orient. Meter installation and management, customer management and billing systems were improved with differing, but mainly positive results by all four Micro-PSP contracts.

Like management contracts, Micro-PSP contracts require a good monitoring and benchmarking system. The introduction of such a benchmarking system was supported by the German technical cooperation (Stoll 2007). Particularly, the PMU at WAJ was supported in its role of monitoring and benchmarking the results of the contracts, for example, by a study on managing PSP contracts (Dorsch 2012). The lessons learnt are that PSP contracts require a thorough division of the roles and responsibilities. Micro-PSP contracts have to be adapted to each phase, with the first phase bringing about the highest profits (Dorsch 2014). Regarding the contract of Balqa, a conflict between WAJ and Engicon is still not resolved.

Two out of three middle governorates are now managed by Miyahuna.

After more than 8 years of support by GTZ/GIZ, the management of Madaba and Zarqa was contracted to Miyahuna in 2014 and 2015 respectively. After the management contract of Miyahuna with Madaba, NRW rates were again reduced from 56 to 42% from 2013 to 2014, mainly by improved billing efficiencies. Overall, the operational cost recovery rates for the middle governorates varied between 46 and 62%, and the NRW rates vary between 41 and 66% (Dorsch 2015 a,b,c, *Table 2.3*). Especially the NRW rates for Balqa and Zarqa are too high – whereas the operational cost recovery rates are too low with less than 50%. The political target for NRW rates is 25% in 2025, while operating cost recovery at 100% is officially targeted for 2020 (MWI 2016).

Reasons for the gap between real figures and political targets are multifold: Regarding cost recovery, the costs for water imports (Disi water conveyor) influence the costs substantially in Zarqa (49% of costs) and Balqa (43% of costs) (Dorsch 2015 a; Dorsch 2015b). The energy costs can also influence the costs substantially, for example, in Madaba where electricity costs represent 56 % (Dorsch 2015c). The high NRW rates can be explained with still insufficient billing and customer management systems, as well as with illegal water connections and insufficient water metering. Also, technical losses are still high, with very high pressures in the system and a lack of efficient leak detection and repair.

Even though utility management of the middle governorates has obviously reached improvements, some task divisions between WAJ and the water companies remain unclear: Zarqa was in 2015 still dependent on some central functions of WAJ with regard to human resource management, laboratories and workshops (Dorsch 2015). Balqa is still struggling with its information management – even though P&L statements have been prepared, Balqa is not ready for a management contract. For the P&L statements, a high input of GIZ and Dorsch Consult was necessary – which raises questions regarding the sustainability of the approach. For Balqa, the German technical cooperation continues its support to optimize water and wastewater management.

2.2.7 Summary on Jordan's Water Utilities

Jordan's water sector has seen a transformation in the past 25 years that resulted in the foundation of three water companies. The transformation is

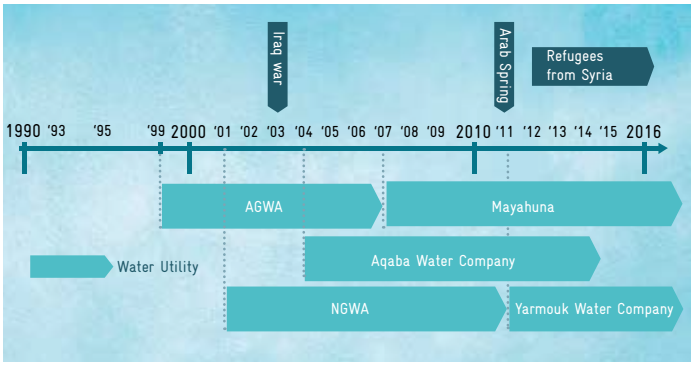


Figure 2.6
Development of Water Utilities in Jordan
AGWA: Amman Governorate Water Authority; NGWA: Northern Governorates Water Authority

Source : own compilation

The decentralized water companies of today struggle with covering the rising operational costs and with high water loss rates

regarded as a success, even though many challenges remain regarding the performance of the utilities. The different milestones regarding the transformation of the water utilities are shown in *Fig. 2.6.*

Water and wastewater services for the Greater Amman Area are now provided by Miyahuna, a commercial entity created in 2007. The AWC is servicing the city of Aqaba since 2004, and the Northern Region is serviced by the YWC founded in 2011. Since 2014 and 2015, Miyahuna is also responsible for servicing two middle governorates, Madaba and Zarqa (CIP 2016, p.10). Miyahuna is the largest water company in Jordan. It provides water to 98% of the 2.5 M residents of Greater Amman and provides wastewater collection services to 80% of the residents (OECD 2014). In 2013, all other companies provided water to nearly 4 M people. The second largest water company by population is the YWC in the North, servicing in 2013 already 1.75 M people. WAJ is still responsible for Balqa and the three southern governorates, Tafielah, Ma'an and Karak.

Two companies, Miyahuna and Aqaba, achieve full recovery of operational costs, while the other water utilities struggle with low rates between 46 and 70%. The NRW rates are still far above the political target of 25%: with the exception of Aqaba, NRW rates vary between 40 and 66% *(see Table 2.3)*.

Table 2.3
Cost recovery and Non-Revenue Water Rates of Jordan's Water Utilities

Sources:
1) P&L statements 2015;
2) KPI 2013

	Water Supply in MCM	Cost recovery rate (operating costs)(Target: 100% in 2020)	NRW Rate (Target 2025: 25%)
Amman2 (Miyahuna)	151,2	103 %	40,6 %
Yarmouk2	76,4	70 %	46 %
Aqaba2	23,2	134 %	26,3 %
Madaba1	9,4	62,5 %	41,5 %
Balqa1	35,6	49 %	65,9 %
Zarqa1	67,8	46 %	66,3 %

2.3 Technical Innovations through partnerships with german companies

Regarding the transfer of water management approaches from Germany and Europe to Jordan, the GTZ cooperation has contributed in many ways to innovation in Jordan. Some of these innovations are explained in this chapter. The outcomes of introducing innovations were mixed: A better understanding of the conditions required to introduce certain innovations was certainly reached. Also, the linkages between the Jordanian and German water sector were strengthened. However, the framework conditions were only promoting one innovation on energy-efficiency for up-scaling because energy prices are high in Jordan.

Innovations from German water companies contributed to capacity development in Jordan.

To promote the introduction of innovations from Germany, GTZ in Jordan heavily engaged in promoting so-called *private-partnership projects* (PPPs), later *Development partnership projects* (DPPs), starting in 2004. Under a DPP, a German or European company engages in development objectives and receives up to 50% subsidies from the BMZ. With this approach, at least five projects were realized in Jordan such as a cooperation to promote energy-efficient pumps with WILO, the introduction of pressure management for water loss reduction with the company VAG; and the cooperation with Hans Grohe and Pontos on greywater use at the Dead Sea.

The cooperation with VAG on water losses has resulted in the reduction of technical water losses in Ain-Al-Basha in Amman. There, considerable water savings could be achieved, even under intermittent supply. The Ain Al Basha demonstration together with other projects have contributed to a global GIZ-VAG project on water loss reduction, with guidelines on water loss reduction now distributed via German Technical cooperation, and with regular trainings on water loss reduction in Germany *(see website www.waterlossreduction.com)*. Water loss reduction projects have been repeated in Latin America, in Lebanon, and in Africa, all inspired also by the Jordanian experience. However, in Jordan, the upscaling did not work. Pressure management requires district metering areas which were partly not clearly aligned in Jordan. In addition, pressure management can achieve best results under constant supply and not under intermittent supply. Also, the incentives to reduce physical water losses are still not well developed. This all contributed to the fact that Miyahuna did not further invest in the pressure management technology.

Energy efficient pumps are scheduled to be installed in the whole country.

The most successful innovation was the cooperation with WILO on energy-efficient pumps. With funding by the *German Environment Ministry* (BMUB), the cooperation could be expanded and has now resulted in a large investment project financed by KfW. The approach of performance-oriented contracts was introduced, and Engicon and WILO won the first contract. The upscaling by WAJ and KfW had to adapt the performance-oriented approach for various reasons. Among them was the fact that the pilot project's conditions could not be replicated at large-scale energy savings were not expected to be so high, and the interference with the system was more complex *(see also Chapter 5)*.

2.4 Regional cooperation and dissemination

Regarding regional cooperation, the Jordanian-German water projects have always contributed to many experiences and lessons learnt for the MENA region. The regional and international dissemination has taken many forms, also in participation in regional conferences and the *Arab Water Week*, and in the participation at the water fair in Munich, *Trade Fair for Water, Sewage, Waste and Raw Materials Management* (IFAT).

Since its foundation in 2006, the experiences from Jordan are also spread via the *Arab Countries Water Utilities Association* (ACWUA). ACWUA is an association that shall contribute to best practices of water utilities in the Arab region, and to exchange of experiences. The organization has now more than 100 water utility members from 18 Arab countries, in addition to private sector companies, NGO's & academic institutions and individual members. The transfer of best practices and experiences is achieved by organizing regional conferences and trainings, and by publishing guidelines and information material. The founding years of ACWUA were supported by GTZ and the *German Water Association* (DWA) with financial support from the BMZ. The experiences from the GTZ and GIZ projects in the region, including those of Jordan, strongly influenced the topics of ACWUA trainings and conferences: Examples are the ACWUA publications on the "Management of water utilities. Case studies from the Arab region" or a reader on energy efficiency in the MENA region, published in 2015.

Also, the projects involving the German private sector have spread in the region and beyond: Amongst others, a strategic alliance on water loss

reduction has been established between GTZ/ GIZ and the company VAG. This has promoted the approach of water loss reduction in GIZ water projects in Lebanon, Africa and in Latin America, especially Peru (e.g. GIZ and WLR 2010). Also, the concept of energy efficient pumps has been transferred to other countries, for example to Brazil.

Through regional networking and exchange from the Jordan-German Cooperation on Water Utilities, the OMS approach as well as other innovations have spread in the MENA region. OMS experts from the German and Jordanian private sector have transferred their experiences in particular to Syria and Yemen. Due to the tragic conflict in both countries, the German Support was stopped. In Egypt and Lebanon, also many experiences were taken up into the technical cooperation, including water loss reduction in Lebanon. In Morocco, Algeria and Tunisia, the transfer was limited because the support to water utilities by GTZ/GIZ was not continued in the new millennium.

The improved water capacity in Jordan spread to the MENA region- through GTZ/GIZ supported projects.

2.5 Jordan's Water Supply today: Achievements and remaining challenges

According to the new Water Strategy (MWI 2016), more than 94% of Jordanians have access to safe drinking water and 93% have access to improved sanitation. However, water supply is intermittent and in rooftop tanks is an integral part of the supply system to store water. Water delivery ranges from once a week in big cities to every other or two weeks in other areas (UNHCR 2014). Water tariffs are still subsidized, with higher tariffs for large consumers. Combined water and sewer bills amount to, less than 0.92% of the total household annual expenditures (Al-Assa'd 2011, in MWI 2016). Many people still rely on water from tankers which is more expensive (see for example UNHCR 2014; Mercy Corps 2014).

Jordan provides capacity and experiences for water sector transformation in the Middle East.

Jordan's water sector is a positive example for commercialization and decentralization, also for private sector participation, in the MENA region. The necessary organizational change was clearly attributed to the support of German technical cooperation. The Water Authority of Jordan, WAJ, who is responsible for water supply, has undergone a substantial transformation process. Through decentralizing parts of WAJ, the transformation process resulted in the foundation of three water companies. Those water companies are responsible for the majority of Jordan's population and municipal

water supply *(see Fig. 2.7).* WAJ owns the companies and manages the different contracts with the water companies through its PMU. Contract management experiences involve international and national management contracts, a management consultant scheme and Micro-PSP contracts. The experiences spread also to other countries in the region.

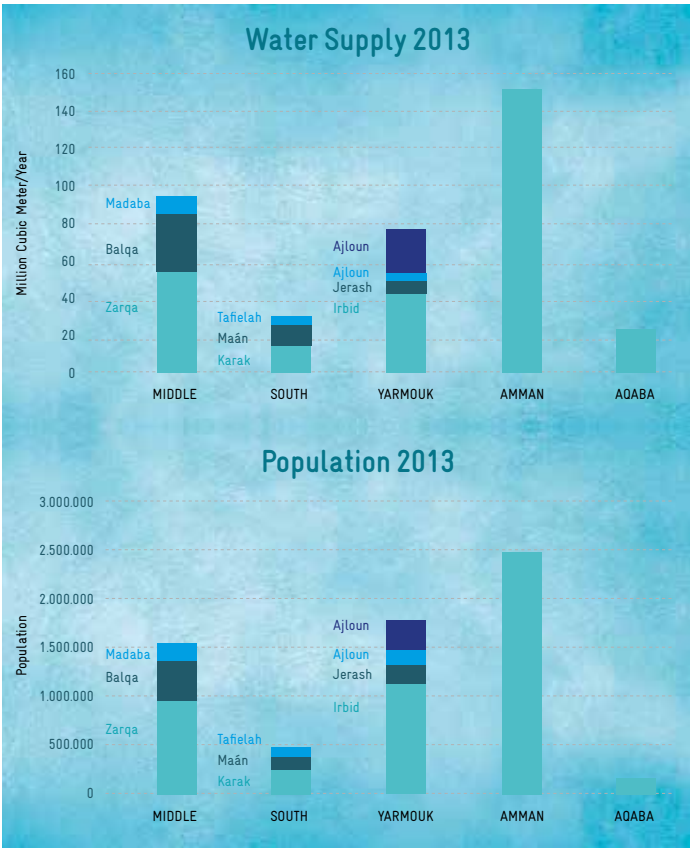


Figure 2.7
Water supply and population served by Utility

Source: KPI (2013)

Jordan has not completed the institutional transformation of the water sector.

However, the roles of WAJ and the water companies are still overlapping: both the southern governorates and Balqa are still to be integrated in WAJ, and the situation regarding the assets is also differing depending on the utility. Also, there is no independent regulatory body. A first step is made with the PMU having a regulatory unit (CIP 2016, p. 10), but as part of WAJ lacking independence.

Looking at total water supply and the population served, there are large differences regarding the water utilities. Amman had the highest amount of water supply with 130 MCM in 2013, followed by the Middle and the Northern governorates with 95 and 78 MCM *(see Fig. 2.7)*. Data from 2013 on the population served has the highest numbers in Amman with close to 2.5 M people, followed by the North with about 1.75 M and then the Middle governorates with close to 1.5 M people *(see Fig. 2.7)*. The population numbers do not reflect the population increase of the past years: The latest census of 2015 cites 9.5 M people in Jordan from previously 6.4 M, which represents a disturbing increase of nearly 50% *(see Fig. 2.7)*. Especially in the North, the population has seen a surge due to the influx of refugees. Both the population served and the amount of water managed in 2013 are shown in *Fig. 2.7*. The comparison of the figures shows that the North has a much lower amount of water per capita compared to Amman, while the amount of water is higher in Aqaba even though the population is comparatively small. Also, the figures illustrate that GTZ/GIZ was involved with improving water supply regarding 92% of Jordan's municipal water for 93% of the Jordanian population.

The challenges for sustainable water supply are continuing to rise.

Looking at the economic performance, the situation is worsening: The revenues for water and wastewater services do increasingly not cover the growing costs in the sector (OECD 2014, p.9). The recovery of operational costs of WAJ and its water companies has gone down from 111% in 2010 to 91% in 2013, and regarding total costs from 70% in 2010 to 57% in 2013 (CIP 2016, p.12). The resulting debts of the WAJ have increased from JOD 430 M in 2008 to JOD 1,000 M in 2013 (CIP 2016). Electricity tariffs increased threefold from 2008–2013 and became a major part of the utilities´ budgets – in 2015, they represented 50–60% of Miyahuna's operation budget with JOD 60 M, about 50% of the YWC's operating bill, and also 52% of Madaba's costs (Dorsch 2015c). Water utilities are still struggling with high commercial and physical water losses as well as unbilled water amounts: Non-Revenue Water rose again in Jordan from about 42 % in 2011 to slightly more than 50% in 2014 (CIP 2016, and *Table 2.3*). High water loss rates are due to old or not adequately maintained infrastructure, lack of customer data including well-metered water consumption rates, illegal water connections, and inadequate bills and collection processes by WAJ.

Meanwhile, the gap of water demand and supply is widening even more, with the costs of water supply projected to further increase (MWI 2013;

CIP 2016). These rising costs result first from the Red-Sea-Dead-Sea project but also from the construction of pipelines to provide water for the increasing population in the North of Jordan. The Disi aquifer, a resource of fossil, non-renewable groundwater, is being exploited since 2013 (CIP 2016). The costs for Disi water are estimated to be over JOD 1 per m^3 only for extraction, not including distribution. Cost estimations for desalinizing water are above JOD 1 per m^3. About a third of the yearly budget for water is granted to the Jordan Government by foreign donors (Mercy Corps 2014).

GTZ/ GIZ contributed for improving utility management, while other crucial issues remain outside the sphere of technical cooperation.

So even though GTZ/GIZ has considerably contributed to improving utility management in Jordan, the challenges remain very large. The challenges are closely interlinked with political issues, for example the refugee crisis, but also with cultural attitudes, the Jordanian society structures, and the economic structures of Jordan. The challenges in the water sector can never be resolved by development cooperation alone.

Nevertheless, the OMS approach has supported the Jordanian transformation process in several aspects: Very important elements include improved information systems on pipelines, assets, and customers, and on the economic situation of the different utilities. Accounting and data management have improved, especially regarding the now-existing profit and loss statements including water balances according to the IWA standard, and the application of geographical information systems. Closely interlinked is the progress regarding the decentralization, since the support was tailored to decentral water utility units. The outcomes achieved by development cooperation laid the basis for management contracts and commercialization of the sector. The WAJ with its PMU has increased its capacities for contract management and also for monitoring and benchmarking the sector. Also, the Jordanian consulting sector has developed remarkably: Engicon and Orient are examples of companies that are able to take over water utility management tasks both in Jordan and in the Gulf states. During the whole time, German support was able to support Jordan with expertise from Germany and Europe, and to open up important cooperation channels on new technologies.

Key Findings and lessons learnt

Looking at the outcomes of 24 years of technical support to Jordan's water utilities, the following key findings and lessons learnt are worth to be noted:

- The OMS approach has strongly supported the transformation of Jordan's water authorities to water companies such as Miyahuna, Aqaba and Yarmouk. Management contracts and Micro-PSP approaches supported substantial progresses of those companies regarding IT and GIS systems, accounting systems and customer databases. Jordan thus became a pilot model for the whole region for private sector participation in the water sector.
- At the national level, GTZ/GIZ has supported WAJ in decentralizing important tasks to the newly founded water companies, with increasing capacities in the PMU to manage contracts with the private sector and to monitor and benchmark the water utilities´ performance.
- The support from GTZ/ GIZ was adapted to the local requirements, with a flexible approach seeking the best solution for the partner. This is underpinned as example by the various forms of IT systems that were introduced as open source systems. Also, the involvement of the private sector was flexible and following the needs of the partner.
- The long-standing cooperation with experts in Jordan and the flexibility of support has contributed to an atmosphere of trust between the Jordanian counterparts and the GIZ staff. The cooperation atmosphere is mainly open and positive from the level of the Water Minister down to the technical staff at the Water companies.
- However, the support by GTZ/ GIZ has not resolved all of the challenges: Water utilities in Jordan are still facing an increase in costs for water supply, especially for long-distance pumping of (also non-renewable) groundwater, increasing energy prices, and potentially increasing costs for desalinized water. The recovery of operational costs varies a lot depending on the utility, with Aqaba and Miyahuna being the only utilities achieving 100% and more. Water utilities need to continue working on their revenues and costs, and they need political support for adapting water tariffs and for the necessary institutional changes.
- The support of GTZ/GIZ has contributed to a significant increase in capacities: Even though capacity development faces the challenges of a significant brain drain, especially to the Gulf, the Jordanian water consulting sector has expanded and competes internationally. Many linkages to the German water sector have been strengthened.

GTZ/GIZ contributed to increased capacities and good bilateral and regional relations.

Nevertheless, the diagnosis of the public water institutions is that they are overstaffed while lacking capacities for complex management tasks (Yorke 2013, p. 53).

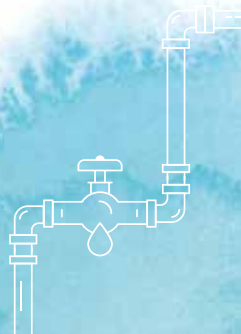
- The long-term cooperation in the Jordanian water sector with Germany had also regional impacts: GTZ contributed significantly to the foundation of ACWUA as the sole association of water utilities in the Arab region. ACWUA has increased its capacities and become an important platform of exchange, even though the association is still dependent on donor funding.
- GTZ in Jordan was very active promoting technology transfer from Germany. As a result, technical innovations were introduced in Jordan such as pressure management for water loss reduction or greywater reuse in large buildings. The promotion of energy-efficient pumps opened a very relevant topic for German-Jordanian cooperation for the future on energy efficiency and renewable energy in the water sector – from water supply to wastewater management. The impact of the other innovations was rather limited regarding the technology, but influenced strategies on water demand management and water loss reduction.
- The objectives of GTZ/GIZ projects were mostly achieved. However, the targets related to cost recovery and water loss reduction proved to be too ambitious on the long term: Even though they were partly improved at local scale and/or during a limited time frame, the reductions were not sustainable due to many external influences, for example, energy costs, costly water imports or the setting of water tariffs.

Key areas for future support should include institutional reform, water loss reduction, energy efficiency and new water resources.

- The approaches of GTZ/GIZ to improve data management, revenue collection, and water loss reduction have had limited success. This is partly explained by challenges limiting the performance of Jordan's water utilities, for example the lack of qualification especially at the handcraft level, but also the staffing principles inside the utilities that rely much on personnel networks. Other challenges include moral attitudes regarding payment of water bills and illegal water connections; and the partial lack of interest in better data management for improved transparency.
- The content of the support therefore does often not include critical, but very crucial issues such as illegal water use, regulation and monitoring, or water tariffs. Also, technical cooperation is very limited in its influence on moral and cultural attitudes. However, such attitudes are also limiting better performance of the sector.

- The OMS approach seems rather technical, since institutional aspects are not included in the four areas of support. However, aspects such as decentralization and the involvement of the private sector were dealt with by GTZ/GIZ in the project context, and some progress was achieved. On the other hand, the necessary institutional changes to improve monitoring and benchmarking and to better separate tasks between WMI, WAJ and the three water companies are still incomplete. As stated by Yorke (2013, p.54), the sector has institutional weaknesses, with an overlap of tasks between MWI, WAJ and the three water companies, resulting in inefficiencies.

Looking at the above, key areas of future cooperation should therefore include institutional reform, better cost recovery, and water loss reduction. Closely linked are topics such as energy efficiency and new water resources, since they influence the costs of water supply considerably. The overarching goal needs to be sustainable water management at adequate costs that also embraces the safeguarding and saving of Jordan's ever so scarce water resources.



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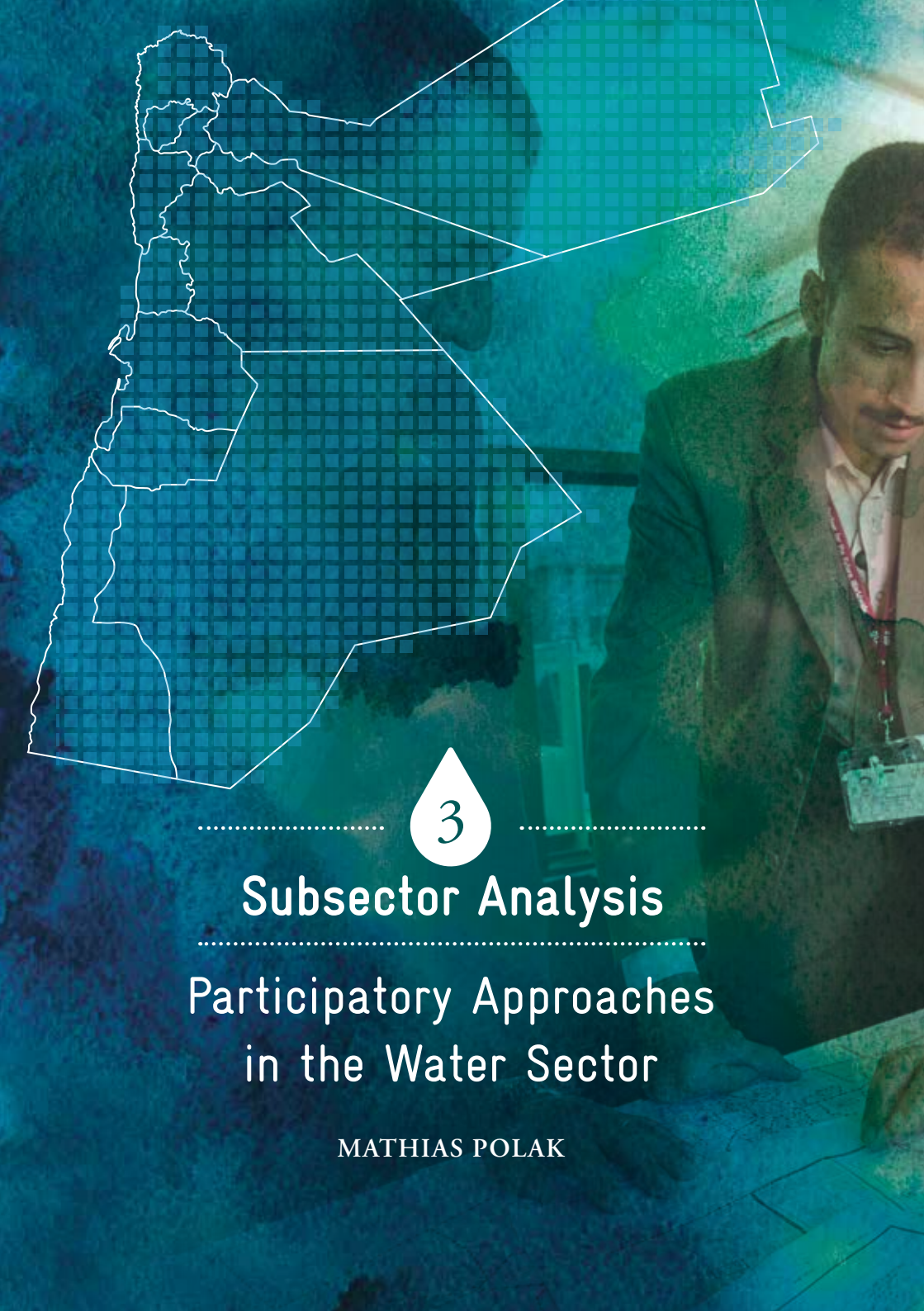


3

Subsector Analysis

Participatory Approaches in the Water Sector

MATHIAS POLAK

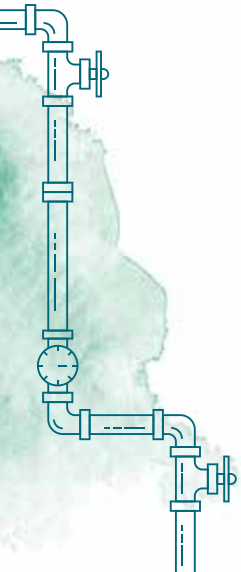
3.0 Participatory Approaches in the Water Sector

3.1 Challenges for participation in the Jordanian Water Sector

Framework conditions changed and the expectations from national water master planning have been reduced.

In the course of the past 25 years, there have been windows for participation, which were influenced if not enabled by international developments. The ascendance of the new King Abdullah II. in 1999 together with the international trend towards private sector participation in previously publicly organized sectors, such as water supply, opened up a window for liberalization of the economy that also impacted on the society. Beside these general political developments, new paradigms gained ground in the water sector in the 1990s and advocated for an increased involvement of water users in water management. *Integrated Water Resources Management* (IWRM) developed into a powerful conceptual framework that guided water sector reforms all around the world. The International Conference on Water and the Environment that took place in Dublin in 1992 adopted the so-called Dublin Principles, which later formed the basis for IWRM. Principle No. 2 reads: "Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels."[1] Furthermore, the IWRM-concept added (among other things) the focus on hydrological boundaries instead of administrative ones and made catchments the preferred planning unit in the water sector.

In the field of agricultural water management, *irrigation management transfer* (IMT) or irrigation management devolution became a common strategy being pursued in more than 60 countries in Asia, Africa and Latin as well as South America (Klemm 2002, p. 4; Garces-Restrepo et al. 2007: ix). IMT is defined as the shift of management authority and responsibility for irrigation systems from a government agency to a non-governmental organisation such as a farmer or water user association. Major objectives of IMT include the reduction of recurring expenditures on irrigation funded by the public sector and stabilise the deterioration of irrigation infrastructure without sacrificing the potential of irrigated agriculture. It is assumed, that IMT will improve the accountability and transparency of the irrigation services rendered to the individual farmer, that it will make the services rendered more cost-efficient, and that it will ultimately enhance the sustainability of irrigated agriculture.



[1] „The Dublin Statement on Water and Sustainable Development"(2016)

The assumed advantages of IMT indicate that the main reason for participation is the failure of the previous top-down approaches to solve relevant problems. Decades of traditional command-and-control approaches have resulted in considerable problems in the water sector. This includes in Jordan for instance the dramatic overuse of water re-sources and the huge water consumption in the irrigation sector.

3.1.1 What is participation and why is it important?

There are very different levels of participation.

Increasing the participation of water users is an integral part of good water governance, which "comprises the mechanisms, processes and institutions that allow all stakeholders, including citizens and interest groups, to articulate priorities, exercise legal rights, meet obligations and mediate differences" (UNDP 2013, p. 72). This definition exemplifies the two-way character of participation: It is at the same time a way to empower water users and a strategy to include them in water management, with defined duties and obligations. When this two-way relation materializes, it creates a win-win situation between water users and government authorities as it enables inclusiveness and more effective water management at the same time.

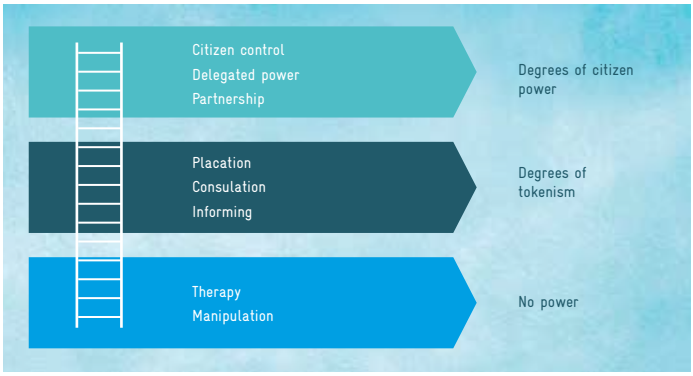


Figure 3.1
Arnstein's ladder of participation

Source: based on Arnstein (1969)

There is a variety of degrees of public participation. A classical system to understand these different degrees is Arnstein's ladder of participation from 1969 *(see Fig. 3.1)*. Many of the participatory approaches around the world would be classified in the middle part of the ladder, labelled as tokenism. The negative connotation to this term is justified if the focus is on the empowerment perspective. From this perspective, anything below partnership is not "real participation". However, from the perspective of more

effective water management, information, consultation and placation can lead to relevant results. Development cooperation usually approaches participation from this angle. The objective is not to lift the partner country's political system to a new democratic level, but "to better reach sectoral goals, for example, water efficiency" (Gerhager and Klien 2013). In this regard, participation is not an end in itself but an instrument chosen purposefully to respond to particular challenges under given circumstances.

3.1.2 Timeline of GIZ's support to Participatory Approaches

GTZ/GIZ supported four different participatory approaches since 1994.

GIZ started to support participatory approaches in 1994. Over the past 23 years, four major attempts to participation were in the focus *(see graphic)*. These approaches differ highly in their thematic and geographical focus as well as in the ambition (What level of participation is envisaged?). Therefore, this chapter consists of four sections that will each outline which particular core problem the Jordanian partners and GTZ/GIZ were trying to address. Then, the details of the participatory approach are outlined followed by the analysis of results and lessons learnt from the particular approach. The final section of the chapter provides an overarching analysis of success factors for supporting participation in Jordan and discusses future prospects for participation in the water sector *(see Fig. 3.2)*.

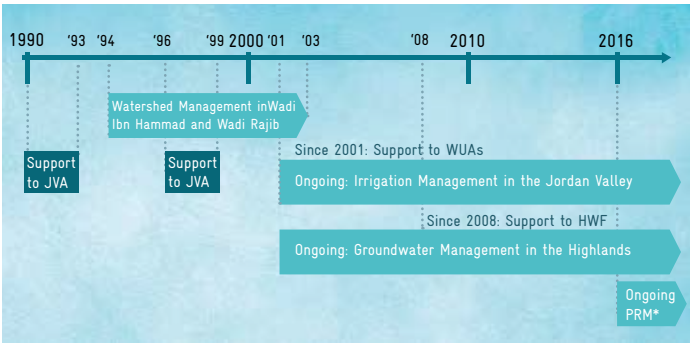


Figure 3.2
Timeline of GTZ/GIZ-support to the Participatory Approaches

Source: Own compilation

3.2 Watershed Management in Wadi Ibn Hammad and Wadi Rajib

Watershed management as implementation of the new concept of IWRM.

A first attempt to introduce participatory approaches in Jordan was undertaken by GTZ as early as 1994 with a project on Participatory Water-shed Management in one pilot area (Wadi Ibn Hammad) in Karak Governorate.

Other pilot areas were included after 1998. Project duration was 9 years (1994–2003) and main implementation partner was the MoA. The project concept was built on the afore-mentioned changes in global paradigms in the water sector. Traditionally, in watershed management the focus was put on geophysical features of a river basin and was hence dominated by a hydrological perspective on water resources. With IWRM, the focus shifted to the socio-economic conditions of people living within the watershed. Therefore, the first objective of the project was defined as follows: Sustainable use of the natural resources soil, water and vegetation in the sense of an ecologically sound multiple use management. This objective included the participatory development of goals and principles of a catchment management approach that took into consideration the sustainable yield of water resources.

3.2.1 Core problem

Degradation of natural resources as rationale for the project.

The core problem addressed by that project was the unsustainable land use and the degradation of natural resources in the pilot area(s). This problem was caused by high population growth and increasing numbers of livestock. At the same time, pasture areas were reduced leading to overgrazing and erosion on the remaining areas.

3.2.2 Approach: Participatory Watershed Management and Self-Help Groups

The project designers were aware that joint community activities and communal co-management are new concepts to this area. Therefore, demonstration sites played an integral part in the project concept to showcase the long-term benefits of rangeland rehabilitation.

Phase 1: Farmers' Groups for Watershed Management and Land Use Planning

From 1994 to 1997, the project included three action fields:

- Erosion protection was started on a number of demonstration plots, namely gully plugging and reforestation within state-owned forest areas.

- Farmers´ groups were established in a number of villages to allow communities to discuss their needs and possible solutions.

- Studies (e.g. on erosion control and soil conservation as well as on water rights and water use) and maps (e.g. land use, vegetation and hydrological maps) were developed using GIS. Furthermore, planning capacities of the respective Watershed Management Unit at the MoA were strengthened and national guidelines for Watershed Management Planning were foreseen.

User participation as key to integrated land use planning.

The combined goal of these three action fields was to develop an integrated and participatory watershed management plan in Wadi Ibn Hammad fed by both, bottom-up received information of users and top-down provided scientific data. The demonstration sites were to convince farmers to take part in the process. Through the institutional support for MoA and the development of national guidelines for catchment planning, scaling-up of results was also conceptualized.

Self-help groups to foster income generation.

Phase 2+3: Income Generation through Self-Help Groups

During the first three years, this theoretically sound approach failed, mainly due to the lack of willingness of farmers to participate. Farmers were only used to "implementation projects", i.e. projects with a focus on construction of infrastructure. Farmers' acceptance of such projects was usually ensured through direct financial benefits. Active participation in the projects was never encouraged, neither by donors nor by the Jordanian authorities. In the GIZ-project, the MoA openly rejected GTZ's inclusive approach and reinforced farmers' expectations for direct benefits from the project.

Another key error concerned the project design: The demonstration sites were all located on government land as it was accessible for the project. It was difficult for farmers to understand why they should participate on planning of activities on these grounds, which did not belong to the community. Furthermore, the project started its activities with reforestation, which made additional land unavailable for grazing. This lead to a reluctance of farmers to be involved in the project. Hence, it became clear that the participatory approach to catchment management and integrated land use planning did not work out, neither from the bottom-up nor from the top-down side.

Therefore, the project's approach was shifted after 1997 towards self-help poverty reduction through income generation. Local self-help groups were created in villages and a revolving fund was established to finance income generating activities and particularly the construction of cisterns. This approach was continued and deepened in the third phase of the project (2000 – 2003). The objective in this third phase reads: "Women and men in self-help groups in selected watersheds manage their resources increasingly sustainable and increase their income."

3.2.3 Results and lessons learnt

Direct results, but limited impact.

The income generation approach led to considerable direct results at the level of villages. Overall, more than 100 cisterns were constructed and about 200 different income-generating activities were supported. However, no reports about the follow-on effects of these results, for instance on the family income, are available.

The participatory approach to catchment management was obviously not successful, but provided important lessons learnt for GTZ. Firstly, it emphasizes the importance of sound analysis of the status quo and the socio-economic conditions. This seems to be a weakness of this project as GTZ was surprised by the high expectations for direct benefits on the side of the target group. However, GTZ was able to adapt its approach quickly and abandon the lost case of participatory land use planning in favour of income generation.

Furthermore, the experience from this project shows that the MoA was not an ideal partner when it comes to innovative approaches that challenge the dominant top-down approach.

Another important finding from this project is the necessity for a multi-level approach. The progress report of 2000 noted that broader impact beyond the self-help groups would require activities in the field of "agricultural policy" especially reduction of subsidies and introduction of cost-covering water prices. These political shifts are considered prerequisites for sustainable resources management and are a constant topic in all other GTZ-projects ever since.

3.3 Irrigation Management in the Jordan Valley

Implementation of IMT through the establishment of WUAs.

GTZ started in 2001 to support the establishment of farmers' groups – later in the form of *Water User Associations* (WUAs) – in the Jordan Valley. The overall objective can be summarized by increasing the efficiency of irrigation management through the transfer of responsibilities from the governmental level, i.e. the JVA, to local level, i.e. WUAs, and hence is based on the international paradigm of IMT.

The Jordan Valley is largely an agricultural area that receives the majority of its irrigation water through one huge water conveyance and distribution system. It covers a total of 450,000 dunum (45 000 ha) of which 410,000 (41 000 ha) are irrigated. The total number of farm units in 2017 was around 12,750 (Personal communication with JVA O&M Directorate: July 2017). The irrigation infrastructure supplying these farm units is owned and managed by the JVA. After its establishment in 1972, JVA was mandated to manage the resources in the Jordan valley including water and to increase socio-economic development. An important part of this mandate has always been water supply and irrigation water distribution.

During the 1990s, different international partners, especially the World Bank and USAID, engaged in discussions with JVA to move towards a greater role of water users in the operation of irrigation systems. JVA perceived itself as an authority fully responsible for all aspects of irrigation water supply, from the source to the field. This changed slowly by the end of the 1990s, when the national discussion in Jordan encouraged reform thinking and liberalisation of political beliefs *(see above)*. Private sector participation became a hot topic in the water sector, particularly in urban water supply. This discourse also affected irrigation management and fueled the introduction of participatory concepts in the sector.

3.3.1 Core problem

During the 1990s, the quality of service delivery in irrigation management in the Jordan Valley constantly decreased. The result for farmers was a shortage of irrigation water at field level led to unrest among farmers and open protests against JVA. The reasons for these problems resulted from a number of interlinked causes, which are outlined in the following paragraphs.

Reduced water availability

Reduced water availability led to reduced quotas for farmers.

In the 1990s, the water available for irrigation in the Jordan valley shrunk for different reasons: In Syria, water was used more intensively in agriculture and new dams were constructed. Both reduced the inflow of water into the Northern Jordan valley. In combination with a severe drought that struck Jordan between 1997 and 1999, this led to reduced overall availability of irrigation water and reduced quotas for individual farmers. In 1999, vegetables and citrus farms received 75% of their allocation, while banana farms received 85% of their quota. Allocations were reduced by 25% in 2000 and 2003, and by 50% and 40% during the summers of 2001 and 2002, respectively. Some areas were left fallow and yields were significantly reduced, notably in citrus and banana plantations leading to a reduced income of farmers (Molle et al. 2007: 430).

The reduced quotas fueled the underlying dissatisfaction of farmers and sparked open protests against JVA. This increased the pressure on the organisation to adapt their management processes in order to reduce conflict situations.

Poor maintenance of infrastructure

Poor maintenance of infrastructure led to water losses and increased distrust between farmers and JVA.

Beside the drought, the poor state of infrastructure in the Jordan Valley was a main reason for unsatisfactory water supply to farms. Many *Farm Turnout Assemblies* (FTAs, infrastructure that directs water from off-farm canals to on-farm pumping lines and gravity lines) were non-functional leading to reduced amounts, timing and reliability of water delivery. Furthermore, these problems translated into substantial water losses. Theoretically, it was JVA's role to maintain and repair the FTAs but the organisation was not able to keep up with the immense amount of individual repairs and acts of maintenance required. Furthermore, the low level of trust between farmers and JVA reduced the willingness of JVA-staff to work at farm level, as they were direct targets for farmers' protests. This lack of supervision at farm level through JVA level opened up space for fraud from the side of farmers *(see below)*, which led to further inequalities in water distribution. JVA's lack of capacity for systematic maintenance was also visible at the level of primary and secondary infrastructure resulting in high water losses at all levels of the system.

The following *Fig. 3.3* outlines the different levels of infrastructure in the Jordan Valley:

- primary infrastructure is used to "produce" and therefore is the source of water in the system (e.g. dams or wells)
- secondary infrastructure is used to transfer large amounts of bulk water from the source towards the user (e.g. canals or bulk pipes)
- tertiary infrastructure is used to divert water at the level of users (e.g. FTAs and on-farm pipes or canals).

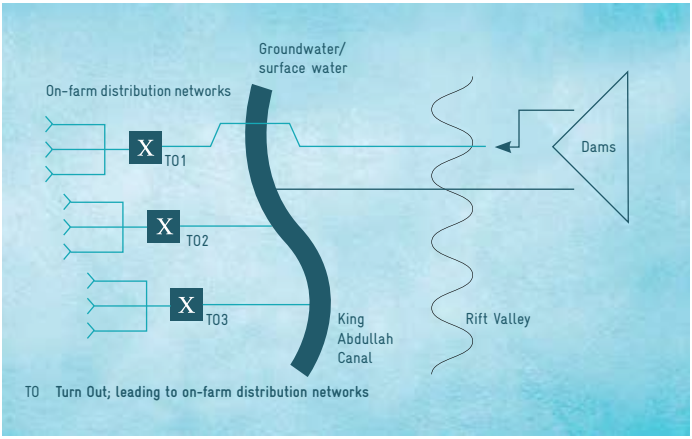


Figure 3.3
Irrigation infrastructure in the Jordan Valley

Source: Compilation of GIZ-Jordan

Fraud led to unequal water distribution.

Fraud and illegal water use

Cases of fraud and illegal water use by farmers were a major obstacle to effective irrigation management in the Jordan Valley in the 1990s. It is beyond the scope of this study to analyse whether these incidences were the reason for inequality and unreliability of irrigation water supply or whether they were responses by farmers to JVA's poor service provision. From GTZ's perspective, the illegal/unregulated distribution of irrigation water was an integral part of the core problem. It included the bypassing of water meters to use irrigation water without payment and the destruction of water meters. These interferences with the distribution system induced a rapid decay of irrigation elements. This in turn generated an increased demand for maintenance which JVA was not able to provide. JVA staff often did not dare to enter farms not knowing whether a meter or a sluice gate was just broken or destroyed on purpose.

Beside the illegal use of water, corruption was widespread. Farmers bribed either ditch riders (i.e. the local JVA-staff responsible for operating tertiary irrigation infrastructure) or even higher officials of JVA to receive more water than the allocated quota. This system worked for well-connected influential farmers who had access to "hierarchical short-circuiting" (Huppert and Urban 1999, p. 58), i.e. who could bypass the official lines of command. Other (poorer and less influential) farmers suffered from the resulting inequality in water distribution in a situation known in institutional theory as "hold-up problem": They were disempowered vis-à-vis JVA staff due to an information deficit and dependent on the good will of officials (ibid: 49). Among both groups of farmers, the confidence base with JVA's official procedures was very low.

JVA's role, mandate and capacities

Double-edged mandate of JVA as service provider and regulator.

A major reason for these problems in day-to-day operations was in JVA's double-edged nature as a service provider and public authority, which resulted from the integration into the *Ministry of Water and Irrigation* (MWI) in 1992. As service provider, JVA was supposed to satisfy the demands of its clients and supply water timely and according to crop requirements. On the other hand, JVA had the mandate to provide a service that may be contrary to the interests of individual farmers, but may be considered as a service to the general public: to manage water scarcity, i.e. to allocate water in such a way that growing differences between demand and supply are balanced out in an equitable manner. Therefore, the water provision service of JVA is both demand and supply driven and is therefore fundamentally different from a commercial (demand-driven) service. The separation of these functions – for which donors argued since the 1990s – still did not take place until today and remains a structural bottleneck of agricultural water management in Jordan.

From the perspective of capacities, JVA was able to manage water distribution and maintenance in times when supply matched the demand. There were increasing problems arising with fluctuating supply and interference on farmers' side. Furthermore, the management capability degraded continuously in the 1990s induced by restrictions on new employments of qualified personnel and loss of experienced staff due to old age.

3.3.2 Approach: Water User Associations

WUA-Approach: Increasing efficiency through decentralising ownership of infrastructure.

WUAs are an institutional approach introduced in many countries around the world with success in order to increase the efficiency of irrigation water management (Klemm 2002). The approach is based on the idea that a decentralisation of ownership of infrastructure and – under ideal circumstances the resources – will increase the willingness of water users to take part in day-to-day operations, especially water allocation among users and small-scale maintenance. This model implements the principle of subsidiarity and is supposed to lead to a more effective water management. In the case of the Jordan Valley, however, no ownership in the legal sense was never transferred, but important management functions were delegated. The transfer of these functions created a sense of ownership among the water users, which was not there before. In this regard, the establishment of WUAs was very much related to a change of mind-sets, both at farmers' side and at JVA side. Both parties refused the approach in the beginning, i.e. influential individuals within the farming community and within JVA tried to stop it as they benefited from the previous system. It was only the joint interplay of a disastrous management situation in the Jordan Valley, a general political tendency towards liberalisation in Jordan and a strong political backing by the then Minister of Water and Irrigation that made it possible for GTZ to go for the WUA-approach. The support from GTZ/GIZ can be distinguished in four phases which are visualized in *Fig. 3.4* and further explained in the following chapters.

Figure 3.4
Four phases of GTZ support to WUA in the Jordan Valley

Source: Adwan and Hayek (2011, p. 540)

Technical support to JVA and discussion of strategy

Before the phase of confidence building started in 2001, there was another period of support, which is not included in the graphic. A project support-

ing JVA in increasing irrigation efficiency was implemented between 1990 and 1993, paused until 1996 (as the GTZ-advisor was transferred to another project in the MWI) and went on between 1996 and 1999. The project aimed at developing instruments for irrigation water management and at training of JVA-staff in using these instruments. In the first phase, the term "instruments" was limited to technical tools, such as simulation models for water distribution, planning documents for the construction of pipeline systems and computer-based management systems. In the second phase, the institutional challenges related to JVA's status as authority and the resulting conflicts with its role as service providers were addressed more openly. During this time, ideas for increased user participation were discussed repeatedly with the partners.

Confidence Building and Clarification of Approach

Overcoming mistrust and introducing innovative ideas – at farmers' and at JVA level.

In 2001, GTZ could start its support to participatory irrigation management as centrepiece of the project "Water Management in Irrigated Agriculture". The first two years were meant to prepare the grounds and to overcome reluctance among farmers and JVA staff. Furthermore, building up of confidence among the farmers to enter into a form of partnership with JVA was an integral part of the initial work. Therefore, many direct discussions with farmers were held by GTZ-staff to raise awareness for the advantages of participatory water management. Only when farmers could be convinced to assume control of water distribution in the network downstream the turnouts (pump stations), joint discussions with the JVA directorates were conducted on how to bring this about.

Pilot WUA in two water conflict areas

During this time, it was decided that user participation should be piloted at small scale first. Two pilot areas were identified, which suffered from particularly poor water supply. Due to a lack of water pressure, more than 50% of the arable land laid idle. Mistrust between farmers and JVA was particularly pronounced in the areas due to the poor service delivery. It was believed that if a participatory approach would improve the disastrous situation in these areas, scaling-up would be feasible. GTZ started to build confidence not only through workshops and trainings, but also invested into necessary rehabilitation work and into flow limiting devices, which allowed the established WUAs a better control of the water.

GTZ also supported the identification of illegal connections and bypasses of water meters in the areas and made the findings a topic for discussion among the farmers. In this early stage animosities among farmers were so

Dialogue with farmers on illegal connections

severe that separate accords have to be reached with just a few farmers in small groups. Rehabilitation progressed stepwise in sections of the network. At the relevant location of work progress, farmers had to identify the mostly hidden means of illegal abstraction. Along with the progress and with irrigation in the rehabilitated sections, larger groups formed setting up control for water flow and lawful abstraction. Once the entire area below the turnout was rehabilitated, the understanding of mutual interdependence and the necessity to set up joint control mechanisms sparked the formation of the entire community, later called association.

Furthermore, GTZ commissioned studies on traditional water management practices, for example, on the community co-management of water sources and traditional modes of arbitration. These practices were widely used in the Jordan Valley before water distribution was centralised by JVA in 1977. WUAs could (partially) be built on these traditional practices.

Establishment of Waster User Associations

Around 2003, the first pilot WUAs were established. A key challenge by this time was the lack of a legal framework for WUAs. As no possible legal status under JVA was foreseen by the Jordanian legislation, it was agreed that WUAs should be established as cooperatives, which have to be registered by the Jordan Cooperative Corporation. As cooperatives, WUAs were obliged to develop internal statutes that specify the objectives, capital, membership procedures and financial and administrative issues. The question of legal status was one of the key topics raising resistance from farmers in the beginning as cooperatives had a negative reputation after a scandal in the 1980s, when influential farmers used cooperatives to privatize agricultural community loans.

Membership in the WUAs was voluntarily. However, in areas with an existing WUA, farmers have to receive their water from the WUA, even if they are not a member. Soon after establishment, it became clear that WUAs tend to reflect the local power structures in the respective area, which are usually based on tribal relations. As heads of WUAs are elected from the members, it was easy for local leaders to come into these positions. This poses challenges for democratic principles within the associations, as now water allocation is formally in the hands of local leaders. However, during the starting phase it was a success factor for WUAs as it endorsed the organisations with power resources and integrated them in the local social setting.

Building capacities and rehabilitating infrastructure.

During the establishment period, a strong focus of GTZ's work was on capacity building (e.g. through study trips with farmers and JVA to Syria and Egypt) and on network rehabilitation in the service areas of the first WUAs. In parallel (through another project), GTZ supported the use of reclaimed water as irrigation water in the Jordan Valley *(see chapter 4)*. This lead to the provision of additional water resources to the Jordan Valley and increased water security for the farmers. Together with improved management through WUAs, positive interdependencies between GTZ projects were created.

Task Transfer

Transferring irrigation management to water user associations.

In 2006, a system of *Task Transfer Agreements* (TTAs) was approved by JVA and the first tasks were legally transferred to five WUA in 2009s. Water distribution to FTAs is the core task, which is part of all existing TTAs. However, there are other competencies that can be assigned if a WUA deemed to be ready and willing to overtake these functions.

The possible functions include:

- carrying out the distribution of water
- maintenance work (where assigned)
- monitoring water distribution and controlling illegal practices
- reporting agricultural pattern
- protecting the water resources (where assigned)
- reporting key performance indicators.

Besides water distribution, maintenance of FTAs is the second important task that is transferred. Currently, this only includes light maintenance (also known as "soft maintenance") and describes all works, which can be done without heavy machinery. The transfer of more demanding maintenance work, for instance on pipes and weirs, is under discussion since the introduction of TTAs. However, until today, the WUAs capacities are not sufficient for these works on the sophisticated irrigation network in the Jordan Valley. The question of increasing the capacities of the WUAs to the necessary level is closely related to the question of the long-term institutional setup in irrigation management in the Jordan Valley.

Other important tasks that WUAs of other countries often perform, especially the collection of water fees, are not part of the package of possible tasks. Farmers in the Jordan Valley have to pay their water fees directly to

JVA, which then transfers the money to the general government budget. This limits the freedom of the WUAs considerably as they depend on transfers from JVA, which they receive for exactly defined activities. Incentives for innovation and cost-effective operation at WUA-level are therefore limited.

In 2017, there were 18 TTAs in place. The financial transfers from JVA to these WUAs sum up to about JOD 500.000 to 700.000 per year. With the delegation of a relevant chunk of its operations, JVA should be able to reduce its running costs. However, this is not possible due to its character as a government agency. Salaries make up by far the largest share of JVA's budget and this share cannot be reduced as the number of personnel cannot be reduced. Today, JVA has more staff than 15 years ago despite reduced tasks. Therefore, the costs for the WUAs appear in JVA's budget as additional expenses and reduce the willingness of the organisation to transfer further tasks.

Hand in hand with the TTAs, an evaluation system for JVA to monitor the performance of the WUAs was introduced. The selected key performance indicators reflect the tasks assigned in the TTA and include:

- number of cases of illegal water use detected by the WUA
- incidents of maintenance carried out (if task is assigned)
- number of complaints received from members
- number of members
- efficiency of water distribution
- operating water meters
- inaccessible farm units.

This evaluation is conducted in all WUAs with TTA on a yearly basis by JVA with support of GIZ. The results are published by JVA. By 2017, the 18 WUAs with TTA cover about 47% of the irrigated land in the Jordan Valley. Of all 12,700 farmers about 15% are members in a WUA (1700 of which 74 are female).

The sharing of responsibilities between JVA and WUAs after successful task transfer is depicted in the following *Fig. 3.5*:

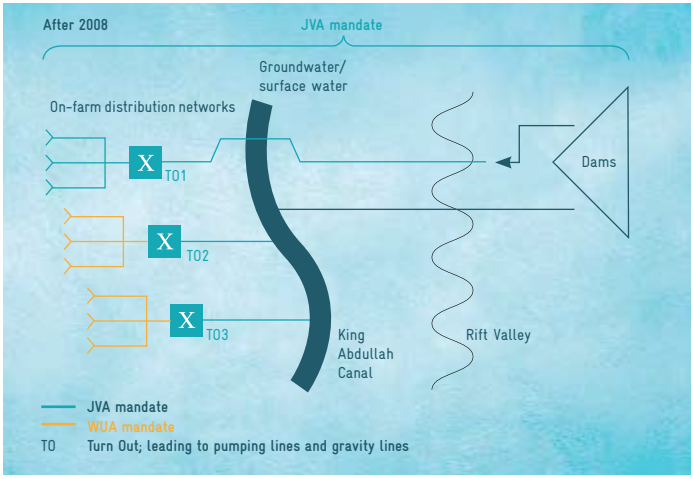


Figure 3.5
JVA and WUA mandate after task transfer

Source: Compilation of GIZ-Jordan

Institutionalization and sustaining of WUAs

Institutional reform in the irrigation sector – beyond farm level.

Jordan's water strategy "Water for Life" of 2009, proposed a revised structure for the delivery of irrigation water. Provision of bulk water would be managed by JVA, whereas the retail distribution of irrigation water would be managed by WUAs. In the long term, the proposed bulk water provider in the Jordan Valley would focus on the regulation and supervision of bulk irrigation water services. Involvement of stakeholders and the private sector in irrigation management would be introduced and gradually promoted.

Since 2009, GTZ/GIZ is supporting JVA in developing a vision of how to implement the provisions of the water strategy. A first step in this direction was the by-law that allows establishing WUAs directly under JVA. It was drafted in 2010 together with a bylaw for WUA-federations. Until now, four federations have been established based on this by-law, in the North, Middle, South and Ghor Areas of the Jordan Valley. These federations cover the same areas as JVA's four directorates. GTZ/GIZ provided four mobile workshops and further equipment to the directorates to strengthen the maintenance capacities at this level. Furthermore, a study on the costs of maintenance at different infrastructural levels is currently ongoing. The goal is to analyse the economic effects if WUA-federations would become responsible for certain maintenance aspects of secondary level infrastructure.

In parallel to the institutionalization of WUAs, GTZ/GIZ supported institutional development at central JVA-level. In 2010, a new unit responsible

mainly for evaluation of WUAs' performance was established. However, in the first years of existence, this unit was attached to the O&M Division and was a rather weak player within JVA. In 2014, it was directly connected to the Secretary General of JVA. This increased the possibilities of the unit, though the number of personnel still stands at two in 2016 (of seven foreseen).

3.3.3 Results and lessons learnt

Improved irrigation water management as main success.

The most obvious result of GTZ/GIZ's support is farmers´ content with the new irrigation management arrangements. The establishment of WUAs led to a much more effective water management through the communities. This resulted in a drastic decrease of illegal water use[2]. Furthermore, WUA-members were gradually trained by GTZ/GIZ to understand the hydraulic principles governing the secondary water distribution systems. Thereafter, they could work together with JVA to optimize water distribution schedules for acceptable working pressures in the pipelines and to take on the responsibility for operating their farm gates (formerly a task of ditch riders). This led to new water distribution arrangements, which allow for better meeting farm water demands.

Support of GTZ/GIZ led to improved cooperation between JVA and WUAs in the rehabilitation and physical protection of irrigation systems. The farmers' intimate knowledge of the functional parts of the secondary irrigation systems helped JVA to improve its maintenance procedures from emergency repairs to preventive maintenance.

These improvements are documented through the evaluations GTZ and later on JVA were conducting. Kloub (2010, p. 34ff) analyses farmers' impression on the general services provided by their WUAs. The share of farmers rating the services excellent or very good varies from 56.5% in the Northern Region of the Jordan Valley to 94% in the Southern Region (Middle Region: 88.1% and Southern Ghor: 67.5%). These convincing numbers correlate with GTZ's focus on the Southern and Middle Region.

From JVA's perspective, the reduction of open protests and the reduction of attacks or harassments against JVA staff are a major benefit. JVA started to realize the benefits of delegated management leading to a change in JVA's attitude from "permissive participation", where JVA remains ultimately responsible for water management to the real transfer of tasks through

[2] For instance, in one WUA (Turnout 28), the number of cases dropped from 137 in 2002 to 27 in 2007 (Mutz/and Hayek 2008, p. 31). There is a methodological concern that only the reporting behaviour might have changed and not the cases themselves. However, triangulation through discussions with JVA-staff, farmers, GIZ-experts and other experts in the sector suggest that this is not the case.

TTAs. This change in mindset is considered a pre-requisite for sustaining WUAs.

These results were mainly achieved in the years directly after the task transfer. In 2016, experts in the sector tend to put the focus increasingly on the weaknesses of the status quo. Despite 15 years of participatory irrigation management, the transfer of maintenance tasks is in its infancy and financial aspects are out of discussion. No path towards an institutional setup for full irrigation management transfer is paved. IMT seems to be stuck in the middle, which affects the sustainability of the participatory model.

Another aspect that is more critically assessed by experts now is the governance situation within WUAs. There is no formal requirement for changes in the full-time positions of WUAs. Especially WUA-heads receive a considerable salary from JVA (JOD 400–600 per month), which makes them clinch to their position. As membership in WUAs is voluntarily, heads of WUA have power to exclude farmers that want to become members. In some cases, WUAs are reported to be dominated by individual families working mainly for the benefit of these families. However, no representative assessment of these problems is available.

Impact and sustainability

Positive impacts on farming economies, but limitations with regard to sustainability.

Irrigation water is a crucial production factor in Jordanian agriculture. Therefore, the improved irrigation water management has led to economic impacts on the farming community. These impacts are key to understand farmers' willingness to participate in WUAs: "The main incentive for farmers investing time in meetings, and in negotiations with fellow farmers and JVA is improved water distribution, leading to the economic benefit of the entire community". One indicator for these benefits is the development of prices for land: "Rents are up by 30%, up to about JOD 3000 per season [and dunum] in the south and north and JOD 5000 per season in the middle of the Jordan Valley, where the availability of reclaimed water is an additional asset to the farms" (Mutz and Hayek 2008, p. 32). Besides this indicator, it is difficult to quantify the economic impacts of improved water supply. Too many factors confound the analysis of production amounts or production value. Nevertheless, there is a clear plausibility for an impact of GTZ/GIZ's support on the agricultural production in the Jordan Valley.

From the perspective of sustainability, the afore-mentioned partial implementation of IMT remains a key challenge. Without JVA buying in a

model of full transfer of local irrigation management, the institutional interplay between government and farmers will remain fragile and irrigation water management will lose effectiveness. Concepts for limiting JVA's role to bulk water supply and regulation of retail are discussed widely in Jordan. JVA has currently no vision of how to develop irrigation management in the future and how to implement the clear political guidelines from the National Water Strategy. GIZ has increased its support for development of an action plan for institutional development in recent years. It remains to be seen how far JVA is willing and able to further reform irrigation management and eventually itself.

Lessons learnt

GIZ's successful support to participatory irrigation management reveals a number of very interesting lessons learnt. GIZ was able to convince JVA to engage in IMT, a concept that is totally contrary to JVA's traditional approach to deal with water users. The analysis of the historical situation shows that GTZ was able to make use of particularly favourable circumstances by the end of the 1990s:

- Slow degradation of JVA's capacities after inclusion in MWI resulting in reduced effectiveness of service delivery.
- General liberalization in Jordan's economy that led to pressure on the government sector to implement modes of private-sector participation for all implementing activities: User participation appeared as a way for JVA's top management to increase effectiveness of irrigation management with maintaining a maximum of control.
- Drought reduced available water and sparked protests among farmers leading to urgent pressure on JVA.

Building on several years of technical cooperation with JVA, GTZ was in the right position to provide an appropriate concept at the right time. Over time, this led to a certain level of mind change at JVA's middle management, which was reluctant towards IMT in the beginning as they feared for their powerful positions. This mind-change enabled a partnership between JVA and farmers, even if IMT is far from being fully implemented.

A key factor for this partnership was the joint interest between JVA and farmers. Even though different opinions on modalities prevailed, there was a uniform understanding of the overall objective: Increasing the effectiveness of irrigation management. The existence of this uniform understand-

ing of the overall objective is a major difference between GIZ's support in the Jordan Valley and in the Highlands *(see chapter 2.3 below)* and an important success factor for any form of participation.

GIZ's whole support in the Jordan Valley is based on the concept of IMT. This concept builds on decades of experiences and the details of implementation have been studied in many countries around the world. Therefore, there was little need for GTZ to be innovative. The conceptual challenge was to adapt the concept to the local circumstances. It has been a success factor that GIZ/GTZ could rely on a concept, which have been proven to work in more than 60 countries worldwide (Garces-Restrepo et al. 2007). Another success factor is the combination of institutional development (establishment of WUAs) with infrastructural support. GTZ was supporting the new WUAs with small-scale network rehabilitation and the installation of flow measurement devices, increasing their technical capacities to manage the irrigation water. Furthermore, GTZ was introducing the use of reclaimed water in irrigation. This was a very successful approach *(see chapter 4)*, which led to an increasing overall availability of water resources making it easier for WUAs to manage water quantities.

Finally, the long duration of GTZ/GIZ's support to irrigation management needs to be emphasized. Institutional changes need time and German cooperation was committed to support the subsector over many years. Today's planning horizons in development cooperation are shorter. However, having time to gather experiences in the sector and allowing ideas to grow is still an important success factor.

3.4 Management of Groundwater in the Highlands

Addressing the massive overuse of groundwater in the Highlands was part of GTZ's support in the subsector agricultural water management since 2001, as part of the project "Water Management in Irrigated Agriculture". After 2006, the project became part of the newly created GTZ Water Programme, which combined all GTZ-activities in the water sector. The promising start of the introduction of WUAs as instrument to improve irrigation management in the Jordan Valley let GTZ and Jordanian partners hope that WUAs could also be an useful instrument in the Highlands. This turned out to be a mistake very quickly *(see chapter 2.3.2)* and GTZ switched its focus to the *Highland Water Forum* (HWF) as core of the support. The support for the Highland Water Forum started in 2008.

3.4.1 Core problem

Dramatic overuse of ground-water resources.

Since 1997, a recurring theme in Jordan's water strategies, policies and laws has been the need to reduce unsustainable groundwater abstraction in the Highlands. A key focus of water demand management has been the reduction of groundwater use for irrigated agriculture, since it consumes over half the abstracted water in the Highlands. Attempts of the MWI to control abstraction based on the Groundwater Law No. 85 of 2002 did not succeed. Relevant instruments such as a licensing system for wells defining a legal amount for abstraction, the right to shut down illegal wells and penalties for withdrawal beyond licensed amount were put in place through the law and its amendment in 2004. However, enforcement of these instruments remained weak and the abstraction rates could not be reduced. Major reasons for the lack of enforcement of existing legislation include gaps in the legal procedures of the Penal Code making it difficult for authorities to file court cases. Furthermore, influential farm-owners, well-owners and the agricultural union were opposed to the law and put pressure on MWI and the WAJ to not enforce it. As a result, the 2004 by-law amendment, providing for revised block tariffs, was never implemented and only a fraction of the planned well closures was realized. However, illegal wells were only one part of the problem. Yorke (2013, p. 42) estimated that in 2011 50% of the 2000 over-exploited wells were constructed illegally. This means that governmental wells and private wells with licenses are at least half of the problem. In 2015, withdrawals from renewable aquifers exceeded the estimated safe yield by about 100% in Amman-Zarqa and in the Azraq basin (MWI 2015, p. 8) leading to a drop of groundwater tables by up to 140m since 1995.

3.4.2 Approach: Highland Water Forum

The classical top-down approach to the problem of over-abstraction has failed in the Jordanian Highlands due to the weakness of the Jordanian Government to implement its own regulations. Therefore, an alternative bottom-up approach was developed by GTZ.

Strengthening of enforcement and transferring participatory experiences from the Jordan Valley.

Before Highland Water Forum:
Support to the MoA and Water User Associations

The starting point for including the Highlands into GTZ's WMIA-project was the idea to establish WUAs in the Highlands, hence transferring the promising approach from the Jordan Valley to other parts of the country. However, this turned out to be not feasible due to two reasons: the very

different situation in the Highlands with regard to water resources and the very different structure of the farming community. While in the Jordan Valley, all farmers depend on water provided to them by JVA through one large infrastructural system, in the Highlands each farmer controls his own water well (or wells). In the context of network extensions for drinking water supply GTZ supported the establishment of a limited number of user groups in Azraq area. However, this was not scaled up due to a growing understanding of the fundamental differences in the natural and infrastructural situation.

Furthermore, the farming community in the Highlands is characterized by large-scale farmers that moved into the area since the 1990s. These farmers are not embedded in local social systems. Their economic interest was focused on a short-term return of investment and dropping groundwater tables were not a fundamental danger to their business model. Therefore, their interest to engage in user groups was limited.

In parallel, GTZ was supporting government authorities to enforce the existing legislation. The MoA became the project partner. GIZ supported the Ministry in setting up an Irrigation Department Advisory Unit that was supposed to be responsible for regulation of groundwater abstraction through farms. However, this unit never lived up to the expectations and remained a paper tiger with no effect on the ground. Beyond the political sensitivities related to Highlands' agriculture, the insufficient staffing of the unit was cited repeatedly as a reason for the malfunctioning. In addition, and probably more important, there were differing understandings between MoA and GIZ about MoA's role in water management. "The MoA, which is the main counterpart institution, remains weak with regard to achieving the project objective, because the staff of MoA understands its mandate first of all to be advising farmers on good agricultural practice and not in the development of concepts for sustainable groundwater management" (Mutz and Hayek 2008, p. 27).

As both strategies (establishment of WUAs in the Highlands and support to MoA) did not succeed, GTZ completely restrategized its support for management of groundwater in the Highlands. By this time, the previous and overambitious objective was abandoned ("Reduction of average annual water extraction from renewable aquifers in the highland area from approx. 430 M m^3/a in 2004 to 390 M m^3/a").

User participation as a possible answer to failed top-down approaches.

Concept of Highland Water Forum

The HWF is a good example of trying participation and a bottom-up approach because top-down approaches have failed repeatedly over the years in reducing overexploitation of groundwater. It was backed by international discussions about self-management of common-pool resources through the users: "The Highland Water Forum will develop stakeholder-based approaches to manage the groundwater resources in the Highlands. This approach will be based on insights from common pool research and will apply tools from change management and innovation research" (Leiber 2010, p. 2).

An important prerequisite for the HWF was a fundamental change in partner structure: Instead of MoA, GIZ partnered with MWI for the HWF. MWI saw itself as the natural responsible body for all water-related aspects. With intense support of the then Secretary General, GTZ managed to anchor the HWF within MWI. Part of that shift was the idea to raise awareness for groundwater over-abstraction and to move away from purely technical interventions. GTZ wanted to ignite discussions at political level to develop counterbalance against the political influence of the farming community. At the same time, the approach towards user participation was conceptually very open. GTZ did not have a clear long-term vision for the HWF, but understood it as an iterative discursive process between farmers and authorities.

The starting point for GTZ's support was an in-depth socio-economic study on irrigated agriculture in the Highlands that analysed the different challenges in water management on the basis of the socio-economic situation (Demilecamps 2010). Furthermore, a stakeholder network analysis was conducted in order to select participants for the HWF that are representative for their stakeholder group. The network analysis also aimed at guaranteeing the participation of stakeholders that are the most important for the HWF: innovators, opinion leaders, persons of trust, networkers, and mediators. This should allow for an efficient ex-change of information between the HWF and the entire stakeholder community (Leiber 2010, p. 4). This methodology was later on replicated by GIZ in the Project "Participatory Resources Management in Host Communities" *(see chapter 3.5.2).*

Another important aspect of the HWF-concept was the inclusion of scientific information on the groundwater situation in the multi-stakeholder discussions. This information was to be prepared by MWI with support of

GTZ and should include visualisation of the current situation and scenario analyses to explain stakeholders the extent of the challenge. This was supposed to trigger a mind change and enable behavioural change, especially among farmers. However, due to delays in the realization of these information products, the scientific information related to water planning never played in the envisaged role in the HWF.

From exchange and aware-ness raising to implementation of a joint roadmap.

The overall objective of the HWF was described as development and implementation of a roadmap towards sustainable management of groundwater resources, including a clear agenda for implementation. The HWF worked on the following aspects:

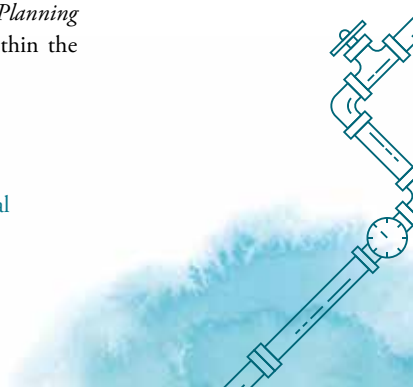
- common understanding of the groundwater situation
- improved awareness for groundwater scarcity among stakeholders
- developing a joint vision for the future of rural areas in the Highlands
- exploring practical options for sustainable groundwater management
- developing concepts for alternative income sources in the region (e.g. renewable energy, tourism, alternative agricultural practices)
- a roadmap towards sustainable groundwater management
- accountability of all stakeholders to the objectives of the roadmap
- agenda for the implementation of the roadmap.

Structure and Development of Highland Water Forum

A multi-stakeholder forum including users and different governmental agencies.

The HWF was officially established in 2010 and mandated by the Royal Water Committee. From the beginning, the HWF was meant to be an umbrella organisation for future Basin Committees in Jordan. In May 2010, the Azraq Basin Committee was established, and in 2012 the Yarmouk Basin Committee followed, both receiving support by GIZ. Meetings are now conducted at the level of the Basin Committees. Each of the committees comprises about 20 key stakeholders from the basin (e.g. local communities, farmers and NGOs) as well as representatives of the authorities involved, i.e. MWI, WAJ, MoA and the *Ministry of Planning and International Cooperation* (MoPIC). Organisational units within the umbrella organisation HWF include:

- the stakeholder fora, i.e. the Azraq Basin Committee and the Yarmouk Basin Committee
- the Steering Committee (responsible for allocation of financial resources and monitoring of the work of the fora)



- the Advisory Board (responsible for provision of scientific advice on particular questions discussed in the fora), and
- the Secretariat.

The secretariat is responsible for support to all participants, the advisory board and the steering committee, provision of information to the stakeholder fora, elaboration of proposals to the stakeholder fora, commissioning of studies, practical arrangements, coordination with donors and monitoring of implementation of commitments by the participation parties. The GIZ Water Programme exercised these secretarial functions. Attempts to transfer these functions to MWI did not succeed due to a lack of personnel on MWI-side. *Fig. 3.6* outlines the structure of the HWF.

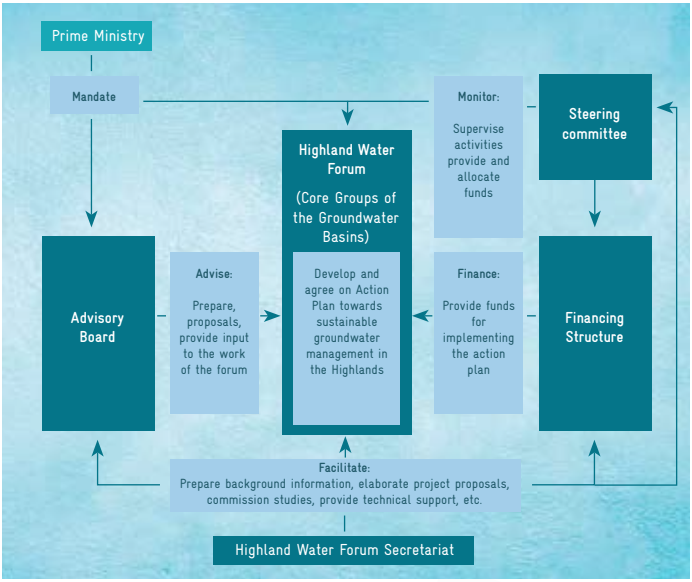


Figure 3.6
Structure of the Highland Water Forum

Source: HWF 2013, p. 5

Different perspectives between water users and government.

Perspectives of stakeholders

From MWI's perspective, the HWF is an opportunity to raise awareness for the relevance of reducing groundwater abstraction. It looks for publicity and the creation of a mutual understanding about the challenge among key water users. The government authorities aim at sharing information about the economic consequences of the drop in groundwater levels. As farmers cannot foresee the future development of water resources, scenario analysis was seen as a tool that enables lifespan cost analysis of investments. This

economic perspective on groundwater levels was supposed to contribute to a mind change among farmers and increase the willingness for collective action. From the side of MWI, there were never plans to go beyond information and consultation in the HWF. No transfer of responsibilities whatsoever to the water users was foreseen.

From the perspective of farmers, as the second key group of participants beside the government authorities, learning about new technologies was the main interest and reason for participation in the HWF. Farmers already experienced the drop in water levels and in some areas farms had to be abandoned by the owners as production was not economically viable anymore.

Discussions between the two groups turned out to be difficult in the beginning. Government authorities, especially high-level decision makers were not used to open dialogue with farmers. The discussions also revealed tensions between farmers and local communities as domestic water supply is also affected by over-abstraction of groundwater through agriculture. GIZ was successful in moderating these discussions and building a working relationship between the participants. An important role in this moderation played the intense accompanying support provided by GTZ/GIZ to all stakeholders. This included pre- and post-meeting visits of GTZ/GIZ-staff to participants to discuss particular aspects and explain the opinion of the opponent side. This meant considerable effort for the Water Programme, but contributed considerably to the quality of discussions in the HWF.

Towards Implementation: Action Plans and Highland Water Fund

Sticks and carrots to change groundwater management.

From the beginning of the HWF it was clear that discussions have to lead to tangible outcomes. Therefore, the development of Action Plans was foreseen as well as a funding mechanism, which could then be used by donors to provide financial resources for improvement of water management. In both existing Basin Committees, action plans were drafted and adopted, in Azraq in 2014 and in Yarmouk in 2015.

The action plans contain two strategic approaches (MWI n.d., p. 4)

- **Induce change** (**"negative incentives"**): Measures to enhance governmental procedures, tools and capacities of law enforcement and controlling of illegal activities will be identified (i.e. capacity building of governmental officials both at national and regional level, more efficient data management (also between sectors).

- **Reward Efforts** (**"positive incentives"**): Measures that take into consideration the direct (economic) interest of water users and reward their ideas of how to change the situation (i.e. subsidies on more efficient irrigation technology, water harvesting mechanisms, alternative energies, etc).

The Azraq Action plan consists of four fields of intervention:

- legal and institutional framework conditions (e.g. enforcement of existing rules, multi-sector coordination, negotiating with neighbouring countries about regional water allocation)
- on-farm water efficiency (e.g. change of cropping patterns, irrigation technologies, use of non-conventional water sources)
- alternative income opportunities (e.g. energy farming, tourism, salt industry)
- community development (e.g. awareness raising, use of non-conventional water sources).

While the first aspect includes activities that are meant to induce change and therefore provide negative incentives, the last three aspects provide positive incentives for water users to change their behaviour. The total budget for implementation of the plan is JOD 5.4 M excluding farm buyouts and up to JOD 19.2 M if the option of farm buyouts was included.

The Yarmouk Action Plan has a comparable structure to the Azraq Action Plan and is comprised of four pillars:

- legal and institutional framework conditions (e.g. enforcement of existing rules, strengthening participation, negotiating with neighbouring countries about regional water allocation)
- technical aspects of water resources management (e.g. introduction of modern irrigation technologies, alternative water sources, introduction of salinity- and drought-resistant crops)
- awareness raising and development of capacities of local com-munities (e.g. increasing knowledge about modern irrigation technologies and water conservation in households)
- financial and economic aspects (e.g. alternative investment opportunities, direct financial support to farmers for reducing water abstraction).

The total budget required for implementation of this plan was estimated at about JOD 23.7 M with the largest portion allocated to pillar two.

With regard to implementation of these plans, obviously the financial resources are the major challenge. The instrument to secure the required means is the HWF. A study was commissioned by GIZ on the modalities of the fund. The study recommended it to be hosted under the HWF and managed through an independent entity. However, MWI did not agree with this modus operandi and insisted of government control over the management. The current compromise in 2016 foresees the separation of financial management, which should be done by WAJ, and administrative management, which shall be given to MWI.

3.4.3 Results and lessons learnt

The most important direct result from the HWF is the improvement of communication between government and farmers. There was a building up of trust that lead to a new level of relationship and increased the available information on both sides. Apart from these atmospheric improvements, a number of projects that were developed by the Azraq Basin Committee have been implemented. Different donors have shown interest in the priorities of the stakeholders, even before the Action Plan was developed. So far, two projects can be traced back to the discussions in the Basin Committee:

- Community Awareness Project introducing drip irrigation on 13 farms (financed by *United Nations Development Program* (UNDP)
- Rehabilitation of monitoring wells (financed by *French Development Agency* (AFD)).

AFD also financed the Terms of Reference for the study on modalities of the HWF. In addition, energy farming (i.e. the use of land for production of solar energy instead of agricultural production) was foreseen to be piloted with the support of GIZ on a number of farms. However, due to delays in approval procedures in the Jordanian administration, the funds were expired and the project did not materialize.

Impact and sustainability

Beyond these direct results, the impacts of the HWF are limited so far. No reduction of groundwater abstraction is measurable and it remains doubtful

how the ambitious Action Plans can be put into practice. The main water savings in the Azraq Action Plan are meant to come from changes in cropping patterns and the introduction of modern irrigation technologies at farm level. Given the limited zeal of the Jordanian agricultural administration with regard to sustainable water management, there is at least a question mark whether these savings can ever be achieved.

Limited impacts so far.

The pillar about the legal and institutional framework in both Action Plans lacks clarification about how the activities will be implemented. For instance, cross-sector coordination (Azraq Action Plan, Activity 1.2.1) is known to be a challenge for years. It remains to be seen whether the involved ministries are willing to overcome their silo thinking due to the discussions in the HWF.

Discussions with GIZ experts indicate that the outreach of the selected stakeholders, especially the farmers, into their community is actually limited. This means that chances of scaling up solutions discussed in the HWF are limited.

Lessons learnt

Unclear perspectives for the HWF.

The GTZ/GIZ-support for groundwater management in the Highlands has started in 2001. The first seven years were largely lost by collaborating with the MoA that had conflicting objectives and was not fully committed to engage in institutional change to promote water efficiency. Furthermore, the idea of setting-up WUAs in the Highlands appears counterintuitive from today's perspective. The major differences in framework conditions, especially the natural resources were known before. This underlines the importance of a thorough analysis of framework conditions before the start of field of support.

The conceptual approach of the HWF was very open from the beginning. References in initial documents (e.g. MGH Concept Note, Leiber (2010)) suggest a relation to the international concepts of co-management of common-pool resources. However, such co-management of local resources through users was never envisaged in the objectives of the HWF. The Forum was conceptualized as a dialogue and consultation forum between the opposing interests of farmers and government. Triggering of mind change among farmers was implicitly seen as the objective of the participatory process. However, there is little evidence from international experiences that discussions and some small-scale projects are sufficient to overcome diametric interests.

Over-abstraction of groundwater in the Jordanian Highlands is a severe problem for the country's water security with a very complex economic, cultural and political context. It remains questionable how far the HWF can contribute to a remediation of this problem.

3.5 Water Supply in Northern Jordan

In 2015, GIZ started a project in partnership with WAJ and the public water provider responsible for Northern Jordan, the YWC, to improve the water supply in three pilot areas in Irbid governorate through increased user participation. The objective of this very recent project reads: Water supply in three host communities is improved. As it has just embarked when this study was compiled, no analysis of results and outcomes can be provided. However, the participation of users in water supply is an innovative attempt to address a burning crisis. Therefore, it shall be presented here.

3.5.1 Core problem

The official number of registered refugees from Syria in Jordan is 655.000 (dated: December 2016) (UNHCR Syria Regional Refugee Response, 2016). However, the latest census shows that the number of Syrians in Jordan is about 1.2 M and the number of foreigners about 2.9 M of a total population of 9.5 M people. Most of the refugees live either in the capital Amman (435.000) or in the northernmost governorates Irbid (343.000) and Mafraq (207.000) (Ghazal 2016). In some areas in the North, population numbers have doubled due to the influx of Syrian refugees as only 17% of them stay in refugee camps while 83% live in settlements. The influx of refugees from Syria into Jordan is placing a heavy burden on already strained services and resources in Jordanian host communities, influencing the housing market, food prices, unemployment and inflation rates. Beside economic challenges, the refugee crisis is also a water crisis. The steep population growth increased the demand for water and put an additional burden on the already stressed infrastructure and on the limited capacities of the YWC.

Domestic water supply in Jordan is intermittent and especially in summertime in rural areas, intervals of supply can reach up to several weeks leading to a shortage of water for households. This is a particular challenge for poor

Influx of refugees poses a huge additional burden on water supply in Northern Jordan.

and vulnerable households who cannot afford to order private water tankers to refill their household tank. An analysis of key challenges in the project's pilot areas from the perspectives of the population and the water provider identified the following: "While low centralized water supply is the main primary cause [of discontent, M.P.] identified by the two groups, poor water quality and unequal water supply are of higher concern for the villagers than for the YWC. The representative of the host communities and the YWC were consistent on such causes of low water supply as physical water scarcity, population growth (including its increase due to refugee influx), poor condition of infrastructure and frequent water leakages. At the same time, the YWC representatives also provide reasons for the poor condition of infrastructure and frequent water leakages by referring to the high costs of infrastructure maintenance, lack of equipment to repair damages, and lack of technical personnel to address all the infrastructure-related problems on short notice. The villagers do not seem to be aware of these aspects contributing to poor infrastructure condition and further to low water supply." (Hofmann-Souki and Stupak 2016, p. 65). Another aspect highlighted by villagers and confirmed unofficially by YWC-staff is the inequality of water supply: Well-connected and influential families can increase the water supply in their area (ibid, p. 67). This illustrates that clientelism and corruption are frequent in all parts of Jordan's water sector, in irrigation as well as in domestic water supply.

Given the set of explanations for the water supply crisis, the project adopted an approach that puts equal emphasis on participation of users and on infrastructure rehabilitation, learning from the approach in the Jordan Valley where also a participatory approach was combined with (small-scale) infrastructure measures.

3.5.2 Approach: Participatory Resources Management in host communities

During an initial assessment in 210 localities in the northern governorates Irbid, Mafraq and Ajloun, the socio-economic conditions and the water situation were analysed in order to assess the anticipated impacts of the Syrian refugees on both aspects. The number of localities was reduced to the three most affected localities hosting refugees that were identified within the assessment. All three localities are located within Irbid governorate (Samar, Kharaj and Fo'arah).

The project applies a multi-dimensional approach combining the improvement of water supply (through infrastructure rehabilitation) with the strengthening of the water provider's capacities (through human capacity development) and the establishment of a participatory feed-back mechanism.

Participatory Community Platforms

Inspired by the experiences of the HWF, GIZ aims at bringing together relevant social groups (including Syrian refugees) with representatives of public authorities and other stakeholders such as mosques, schools and local community-based organisations. The idea is to establish dialogue and exchange platforms at community level.

Topics to be discussed include:

- identifying perceptions about service quality and water problems from the perspective of provider and users
- informing users about planned network rehabilitation and asking for feedback
- raising awareness about water saving potentials.

GIZ's approach to these meetings is very open. There is no clearly defined expectation regarding the outcome of the exchange. However, GIZ has clear expectations regarding the quality of the process: participation of women and refugees is encouraged, though there is no way for GIZ to ensure equal participation of these groups. Impressions from the first meetings in 2016 indicate that the equal representation of women and vulnerable groups may be a challenge.

Participation as a way to improve communication between customers and the provider.

Capacities of Water Utility

Another line of work that is still in its infancy by the end of 2016 is a Capacity Needs Assessment in the Regional Operating Unit of the water provider as well as in the respective municipalities. The aim is to define an adequate Human Capacity Development concept that will lead to improved service quality. The results from the stakeholder participation will be an integral part of this improvement, as it will provide YWC with much better and more detailed knowledge about the problems of water supply from the users' perspective. The concept of user participation should be anchored institutionally within YWC in order to allow for a scaling-up to other parts of YWC's service area. Furthermore, a water supply concept for vulnerable

Introducing customer communication into the work streams of the provider.

groups with a focus on people with handicaps shall be developed together with YWC in order to increase the water provider's responsiveness to the needs of this group.

Combination of capacity development and infrastructure improvements.

Rehabilitation and improvement of infrastructure

This line of work has commenced in April 2017. The basic idea is to rehabilitate infrastructure hotspots in order to improve the water supply in the pilot areas and to create a tangible outcome for the community. This shall increase people's and YWC's willingness to engage in dialogue. As a no-regret measure, the project provides direct support to vulnerable groups such as additional household tanks and wheelchair friendly lavatories in schools and mosques in the three localities Samar, Kharaj and Fo'arah.

3.5.3 Results and lessons learnt

As the project is in its starting phase when this study was compiled, no long-term impacts are measurable as of now. However, the first community meetings give some indications. In the beginning, YWC was rather reluctant with regard to a participatory approach in water supply. The fear was that it would make business for the water provider more difficult without providing tangible benefits. After a series of meetings, YWC is more positive starting to realize that the knowledge about customers' perspective can be very valuable to a service provider and can be a key step to improve services. Water users are satisfied by the improvement of communication with YWC, which was de facto non-existent before. These very preliminary experiences illustrate that exchange and communication between stakeholders are a major gap in the Jordanian water sector. In how far the project approach can have impacts beyond improved communication remains to be seen.

3.6 Outcomes and prospects of Participatory Approaches

Different levels of ambition in the supported approaches.

The four examples show that participatory approaches have very different ambitions with regard to the envisaged depth of participation. Watershed management and WUAs in the Jordan Valley aimed at the transfer of certain tasks from authorities to local user groups. On Arnstein's participation ladder, they can therefore be understood as attempts to establish a partnership. The HWF and the very recent community fora in host communities look for information and consultation, in the case of the community fora possibly placation of citizens. No tasks should be executed through local communities in these two cases. Therefore, they would be labelled in Arnstein's terminology as tokenism, which may be a too negative term, given the realities of Jordanian politics and power structures. Improved consultation between government and citizens is a relevant result under the given conditions. However, the outcomes one can expect from a consultation forum are different from the expectations towards a functioning co-management. If partnership approaches work well, they can lead to the achievement of sector-specific objectives (e.g. improvement of efficiency of irrigation management in the Jordan Valley). It would be overambitious to expect the same from a consultation forum. Therefore, it was inadequate from the beginning to expect the HWF to contribute to a reduction of groundwater abstraction, as the core problem (lack of enforcement through the government) remains untouched by the forum.

One approach aims to establish partnerships between users and government (WUAs).

Two approaches aim to establish a partnership between information and consultation (HWF and community fora in host communities).

Another important question around participation are the costs. If a partnership mechanism (co-management between state and local community) is working well, it should lead to a reduction of costs for the government as citizens take over some tasks. This did not materialize in case of the WUAs in the Jordan Valley, as JVA was not able to reduce its personnel according to the reduced functions. Consultation fora do not have direct cost-saving potential. In contrary, they require additional funds. If they work well, they may increase the long-term effectiveness of government policies and thus reduce costs. This is because the information base of authorities is increased and decisions are better adapted to the citizens´ needs. However, this is a long-term and very indirect causal chain and the analysed examples in this study could not prove such effects.

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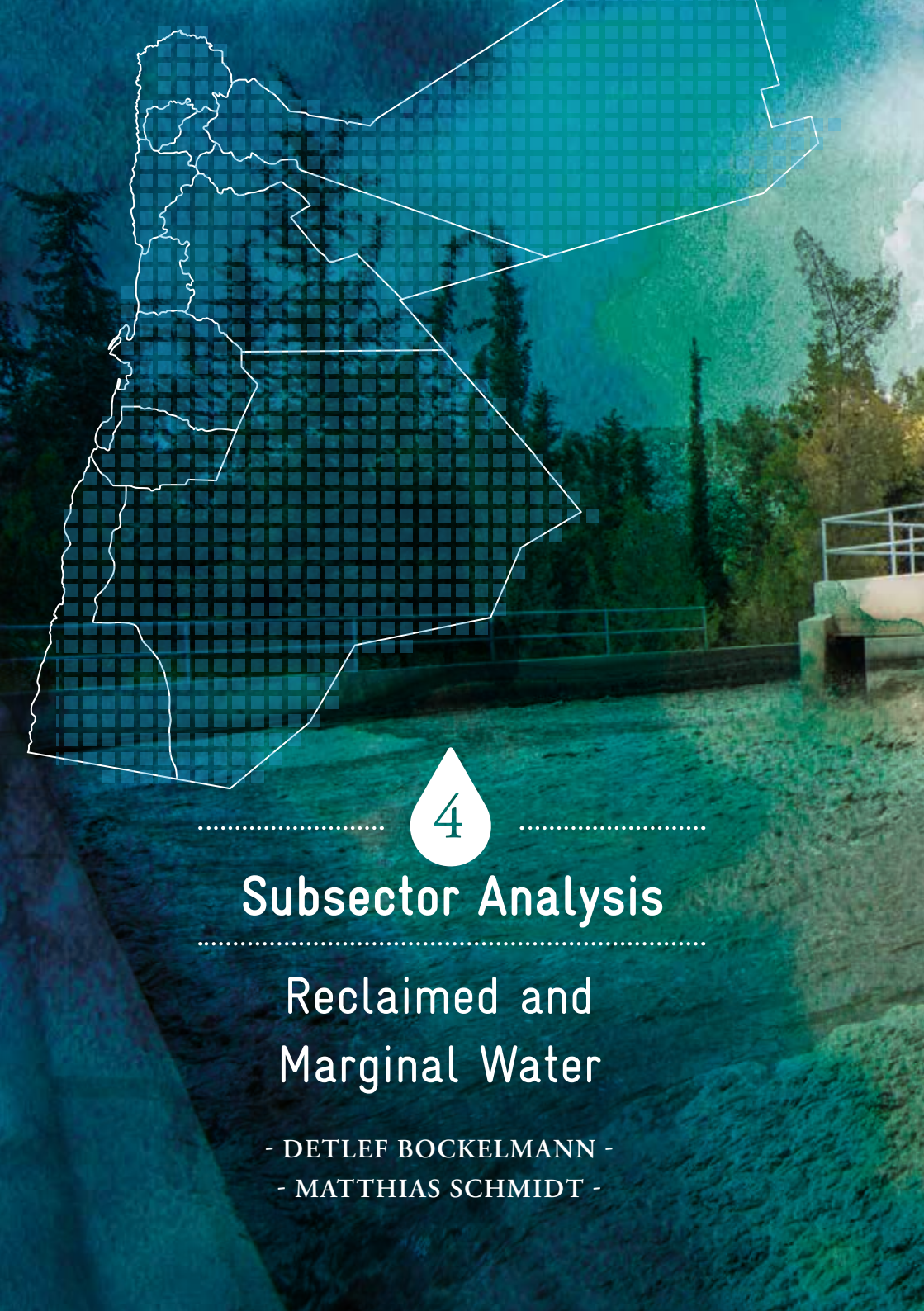


4

Subsector Analysis

Reclaimed and Marginal Water

- DETLEF BOCKELMANN -
- MATTHIAS SCHMIDT -

4.0 Reclaimed and Marginal Water | Deflef Bockelmann, Matthias Schmidt

4.1 Challenges for participation in the Jordanian Water Sector

Jordan has always been a water scarce country. Over the past 30 years increasing population numbers and augmentation of agricultural production increased the pressure on scarce resources. Especially in the Jordan Valley, one of Jordan's agricultural irrigation hotspots, demand for irrigation water could not be met anymore in the 1990s. Since the 1980s, the availability of fresh water resource decreased continuously.

The reasons therefore are:

- intensification of groundwater and surface water abstraction in the Syrian parts of the Yarmouk river watershed
- increasing groundwater abstraction for urban centres (particularly Amman and Irbid)
- intensification of agricultural use of water resources in the Jordan Valley
- changes in precipitation patterns, potentially due to impacts of climate change.

These factors are accompanied by a general high variability of precipitation that makes rain-fed agriculture in the Jordan Valley almost impossible. Therefore, farmers in the Jordan Valley depend on a constant supply with irrigation water. A drought period starting in 1993 worsened the situation and made the imbalance between supply and demand a national challenge.

Shortage of water resources makes the use of marginal water necessary

Increasing the use of marginal water *(see box)* resources appeared as a logical solution to these problems. Since the inauguration of the King Talal Dam in 1977, treated and blended wastewater was available in the Jordan Valley. It originated from the Greater Amman area and was treated in a stabilisation pond system in Khirbet-as-Samra. After treatment, the water was collected in the Dam that had a capacity of 86 MCM. Here, the wastewater was blended with freshwater and channelled into the King Abdullah Canal, the main water carrier that stretches over 110 km from North to South in the Jordan Valley. The Canal mainly transfers freshwater from the Yarmouk southwards. In Deir Alla in the Jordan Valley, parts of this freshwater are

Marginal water:
The concept of marginal water defines two major types of water with marginal quality compared to fresh water:

- Wastewater, especially resulting from domestic and industrial uses
- Saline and sodic spring and groundwater or agricultural drainage water

In this chapter it is used as an umbrella term for all types of water resources other than fresh water.

Reclaimed Water:
Effluent derived in any part from sewage from a wastewater treatment system that has been adequately and reliably treated, also known as recycled water.

Brackish water:
Brackish water is saltier than fresh water, but not as salty as seawater. It may result from mixing of seawater with fresh water, as in estuaries, or may occur naturally as geogenically salty groundwater.

Greywater:
Household wastewater (as from sinks, bath tubs or washing machines) that does not contain serious contaminants (as black water from toilets)

Sludge:
Sludge refers to the residual, semi-solid material that is produced as a by-product during treatment of industrial or municipal wastewater.

directed to supply Greater Amman Area. This freshwater is then replaced with the treated wastewater from Khirbet As-Samra.

The fast urbanisation in Amman led to a rapid increase of the amounts of wastewater channelled to Khirbet-as-Samra, quickly overstretching the treatment capacities. As a consequence, the water quality decreased considerably. However, the scarcity of freshwater forces farmers since the 1990s to use wastewater for irrigation. This particular situation opened opportunities for the German Development Co-operation to engage in the field of re-use of marginal water resources. This analysis describes the different

phases and projects of GTZ/GIZs engagement in the Jordanian water sector that aim at an increase of Jordan's capacity of water usage through the use and treatment of marginal water sources.

4.2 Timeline of GTZ/GIZ-support to the (Re-)use of Marginal Resources

GTZ/GIZ engagement in management and reuse of marginal and recycled water started in 1995 with the "Brackish Water Project" followed by a project on "Re-use of Reclaimed Water" between 2003 and 2006, which was merged into the Water Programme in 2006 as a component *(see Fig. 4.2)*.

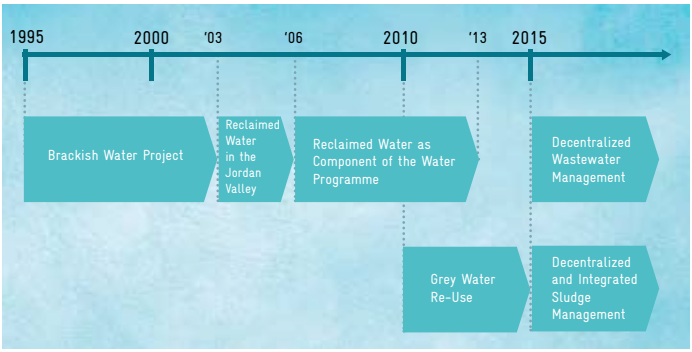


Figure 4.2
Timeline of GTZ/GIZ-support to the Use of Marginal Water

Source: own compilation

This component on "Reuse of Reclaimed Water" went on until 2015. In 2015, two new wastewater projects started. One project focuses on decentralized sludge management and the other on decentralized wastewater management. The following graphic shows the time sequence of GTZ/GIZ involvement and support to the various marginal water and wastewater projects between 1995 and 2016.

4.3 1997 – 2005: Initial Implementation of GTZ's engagement in (Re-)use of Marginal Water

Two approaches were supported by GTZ since 1997. One approach focussed on the use of brackish water (i.e. spring and ground water with a certain level of salinity), the other one aimed to use reclaimed water. Both approaches aimed equally at increasing water availability for agricultural irrigation in the Jordan Valley.

4.3.1 Use of Brackish Water in the Jordan Valley (1997 – 2003)

The project "Use of Reclaimed Water in the Jordan Valley" (2002 – 2005), aimed to foster the use of reclaimed water for crop irrigation in line with public health standards.

The use of brackish water was nothing new to the population in the Jordan Valley. The sources of brackish water referred to local sources and outflows of Wadis with high levels of salinity that prohibits the use of this water as drinking water. About 10% of the irrigated area in the Jordan Valley were at least partly irrigated with brackish water. These sources were used by individual farms, which had much better chances to continue production throughout periods of drought. The examples sparked an interest of other farmers for brackish water as a resource.

The project "Use of Brackish Water in the Jordan Valley", implemented between 1997 and 2003 had the objective to examine the impact of brackish water application on soils and crops. The aim was to prove the consequences of the application of brackish water on fields and improve the general reputation of this water source. The core problem addressed by the project were knowledge gaps and inadequate irrigation practices of farmers that impeded an economically and ecologically sustainable use of brackish water.

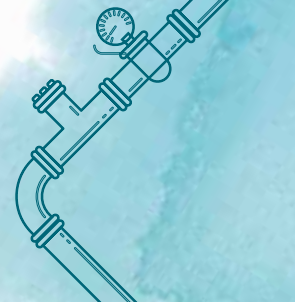
The sustainable use of brackish water requires to meet specific guidelines.

Approach: On-Farm Work combined with the development of Scientifically Sound Guidelines

Irrigation with brackish water, especially when using water with a salinity of more than four decisiemens per meter on susceptible cultures, can lead to reduced or delayed yields. Farmers were practically forced to cultivate a limited number of crops. The project started to make farmers familiar with adapted agricultural practices that allowed them to cultivate a broader range of crops.

The Brackish Water Project consisted of the following components:

- soil inventory and closing scientific information gaps
- water inventory (e.g. identification of quantitative potential of brackish water resources)
- assessment of past irrigation practices with a focus on the use of brackish water



- assessment of natural vegetation in the project area
- assessment of on-farm practices with regard to irrigation and fertigation
- establishment of a monitoring system to identify and assess possible impact on soil quality to govern any potential harm
- introduction of GIS as a management tool within JVA.

The project had a strong focus on research and was working with field trials. Field engineers from the project visited the farms on a weekly basis to provide advice and to document experiences and production results. Results of these trials became the basis for a handbook for agricultural extension officers published in 2003. Furthermore, the project developed "Guidelines for Brackish Water Irrigation in the Jordan Valley" that were consolidated through capacity building for agricultural extension services and other experts.

Results, limitations and lessons learnt

The project's main achievements were to reduce reservations of farmers and the public vis-à-vis marginal water resources. The project provided adequate guidance about water quality and indicated that brackish water resources can be a way to provide increased volumes of water for irrigation. For the first time, support was given to the organized and scientifically accompanied use of marginal water for irrigation in the Jordan Valley.

According to the final evaluation of the project, participating farmers showed great ownership. Beside the fact, that farmers saw the direct economic benefit they could draw from the project, two key methodological aspects of project implementation were cited as reasons for this ownership:

- Experienced and successful farmers with different social backgrounds had been included as expertise for the use of brackish water and for sustainable agricultural practices. The transfer of knowledge from farmer to farmer became a success factor for the project.
- Project staff strongly identified with the needs of the target group and became a mouthpiece for farmers' issues vis-à-vis JVA and other authorities. This fostered a good relationship between the project and farmers.

However, on a scientific basic, the use of brackish water showed severe weaknesses, especially the risk of soil salinization as well as the lack of continuous supply as the available quantities of water are limited. Given these

results, the use of re-claimed water appeared to be the more promising alternative and was increasingly in the focus of discussions between the Jordan Valley Authority and GTZ (GTZ 2004). Therefore, the Brackish Water Project was phased out and the German support was focussed on reclaimed water.

4.3.2 Use of Reclaimed Water in the Jordan Valley (2002–2005)

The project "Use of Reclaimed Water in the Jordan Valley" (2002–2005), aimed to increase the use of reclaimed water for crop irrigation in line with public health standards. It built on the results of the Brackish Water Project and the fact that there was already a functioning water transportation system based on gravity between the Jordan Valley and the Highlands. This led to the fact that fresh water use in the Valley was increasingly substituted by steadily increasing quantities of reclaimed water

The use of reclaimed water possesses a key advantage compared to brackish water: Fresh water can be substituted without the negative consequences of saline re-sources such as subtle loss of soil productivity due to salinization. In addition, the use of reclaimed water was seen as a starting point for a process of valorisation of wastewater, therefore providing another rational for increasing wastewater collection in Jordan.

However, at the beginning of the project, reclaimed water from the King Talal Dam was only available in the southern Jordan Valley and possessed high salinity and phosphate levels. It was only with the modernisation of the Khirbet As-Samra treatment plant that enough reclaimed water with acceptable nutrient content was to be made available to farmers in more elevated areas such as Shifa Ghors.

Approach: On-Farm Work combined with the development of Scientifically Sound Guidelines

The methodological approach focusses on the transfer of adapted agricultural practices from farmer to farmer.

At the beginning of the project, a baseline survey was undertaken at randomly selected farms to gather information on agricultural practices. It turned out that about 70% of the farmers had no knowledge about the nutrient content of the wastewater they were using for irrigation. The others indicated to have knowledge, but did not adapt their use of fertilizer accordingly. The methodological approach of the project relied on the experiences of the Brackish Water Project and focussed on the transfer of

adapted agricultural practices from farmer to farmer. These practices took international expertise in the use of reclaimed water into consideration and translated it into the Jordanian context. Agricultural guidelines complemented the field work and paved the way for scaling-up of experiences.

The project selected a number of pilot farms that were accompanied throughout the project duration. There irrigation and fertilization practices were systematically monitored and analyzed. This approach helped to close gaps that existed within the Jordanian agricultural research.

The project focussed on advisory services to farmers in order to strengthen knowledge and increase the acceptance of reclaimed water. Farmers were trained in proper application of reclaimed water to avoid harm to them, their workers and families. Further, farmers were familiarized with the advantages of the nutrient rich water in order to optimize the use of fertilizers. The project collaborated closely with the project WUAs in order to reach out to farmers. Community workshops were held together and farmers were sensitized on participatory approaches and on the use of reclaimed water alike.

Beside the direct work with farmers, the project undertook important activities to institutionalize the knowledge about safe use of reclaimed water within the Jordanian agricultural bureaucracy. The project comprised the following key activities were undertaken in this regard:

- development, on a scientific basis, of guidelines for fertigation (i.e. use of fertilizers for irrigation) using reclaimed water
- preparation for ensuring the protection of human health and the hygienic safety of agricultural products
- support to elaboration, adoption and enforcement of irrigation water quality guidelines
- elaboration for a modified irrigation water monitoring programme
- elaboration of a groundwater and soil monitoring concept
- development of a first proposal for a State Monitoring System for fresh fruit and vegetables.

The public authorities were supported in fulfilling their supervisory functions regarding the use of reclaimed water. Beside the development of necessary technical and regulatory documents, this included the establishment of inter-sectorial working groups to improve the coordination between

MWI, JVA, WAJ, MoA and MoEnv. GTZ's contribution was mainly to serve as an honest broker that initiated the necessary dialogue beyond the sectorial borders. This cooperation between the Jordanian institutions was an important foundation for the establishment of a comprehensive governmental monitoring system for the use of reclaimed water, which was supported by GTZ in the following phase of the project *(see below)*.

Results and limitations

For farmers, the main benefit of the projects was the fact that the propagated fertigation practises largely avoided yield depressions due to increased salinity and saving expenditures for fertilizers. Thus, the sum of propagated measures induced tangible farm profitability

Another main result of the project was that farmers accepted reclaimed water as an additional source for irrigation. The access to the "new" water resource alleviated the shortage of water in the Jordan Valley. Furthermore, the decrease in fresh water demand of the agricultural sector, enabled the provision of remaining fresh water for domestic use in Amman. This should not mask the fact that farmers´ priority for fresh water use in irrigation was still predominant. However, farmers and institutions such as the *Jordan Valley Authority* (JVA) and the Ministry of *Water and Irrigation* (MWI) accepted the new resources after sensitization and awareness raising.

The project paved the way for increasing institutional and public acceptance of reclaimed water.

In 2005, 11.000 ha of land (ca. 40% of the irrigated area in the Jordan Valley (Molle et al. 2008, p.427) could be irrigated with reclaimed water (diluted with freshwater), without any restrictions on the cultivated plants. The project was instrumental in developing a guideline and a first monitoring system for this irrigation that ensured the safe cultivation even of vegetables meant to be eaten without cooking.

Other positive effects were the improved institutional collaboration between water and agricultural institutions. This laid the foundation for the crop monitoring system that was developed in the subsequent phase of the GTZ-support.

Around 2005, the continuously increasing amount of waste water from the King Talal Dam (caused by population growth in the Greater Amman Area) together with the construction of new collection points and an increase in connections enlargement of sewage infrastructure made it possible to provide enough water for the central Jordan Valley.

An adequate level of treatment could not be guaranteed, resulting in high levels of salinity and phosphate.

A challenge for the reclaimed water project was to guarantee an adequate level of treatment. During the project duration, this was not possible since Jordanian wastewater treatment plants and especially the overstretched stabilisation pond system in Khirbet-as-Samra did not operate according to international standards. Therefore, reclaimed water contained high levels of salinity and the level of nutrients (especially phosphate) impeded the reclaimed water's safe use.

4.4 2006 – 2013: Scaling-up of Reclaimed Water and the development of a Risk Management System

In 2006, all water projects implemented by GTZ were merged into one comprehensive *technical cooperation* (TC) programme. The support of the use of reclaimed water became one of the components of this programme. In 2008, Jordan's wastewater management sector was revolutionized by the inauguration of the As Samra wastewater treatment plant. The plant that was financed by USAID treated in the beginning an average 267,000m³ of wastewater per day, thus dealing with the sewage from 2.2 M inhabitants of the Greater Amman and Zarqa area (Water technology.net 2017). After enlargement in 2015, the design capacity was increased to 360,000 m³ and the average daily amount of wastewater treated in 2015 was at 295,000 m³ (MWI 2015).

Between 2006 and 2010, the amount of treated wastewater available for agriculture increased by more than 25% (MWI 2015). In this period, reclaimed water became the quantitatively most important source of irrigation water in the Jordan Valley.

The amount of treated wastewater increased by more than 25% between 2006 and 2010.

Another consequence of As Samra was a change in the quality of reclaimed water. Existing quality standards of wastewater treatment did not fit to optimal fertigation requirements as they aimed at a maximum reduction of nutrients in order to provide water that is fit to be discharged into water bodies. *Ammonium nitrate* (NH4) and phosphate as components of reclaimed water were highly welcome in agriculture as additional fertilizers, whereas phosphate had to be eliminated in recycled wastewater due to water protection requirements (e.g. avoiding eutrophication). This shift in water quality required adaptions of GTZ's support to farmers as reduced fertilization was less in the focus than before. The fertigation guidelines reflected the nutrient content of the water, soil conditions, plant nutrition

potential, seeding date, extension of the chosen vegetation period, and the climatic conditions of the location. Later on, the economic benefits of fertigation were assessed by GIZ experts and JVA representatives (GTZ 2008). In 2008, 500 out of 3,000 farmers in the Jordan Valley were trained by GTZ in the safe use of reclaimed water and appropriate fertigation.

Furthermore, the reclaimed water component started the development of qualitative standards with the aim to reduce the risk of health problems when consuming agricultural products from the Jordan Valley.

4.4.1 The State Crop Monitoring Programme

SCMP safeguards the quality of the crops and increase consumers´ confidence in agricultural products.

The use of reclaimed water constitutes a risk to human health and the environment if it is not applied correctly. In order to address this well-known fact beyond the farmers' community, the GTZ-support focussed on the establishment of a state crop monitoring programme. This programme should safeguard the quality of the crops and increase consumers' confidence in the agricultural products. The project facilitated the development and smooth implementation of monitoring procedures, appropriate farming practices as well as commercial benefits for farmers and consumer protection measures.

The *State Crop Monitoring Program* (SCMP) was initiated as a comprehensive governmental monitoring system for fresh fruit and vegetables, which focussed on the project area in Jordan Valley (but would also be applicable for the whole of Jordan). Institutions involved in the implementation included WAJ, Ministry of Health, Ministry of Environment, JVA, MoA, *Jordanian Food and Drug Administration* (JFDA) and the *National Centre for Agricultural Research* (NCARE) for the monitoring of parameters on soil, water and crops *(see Table 4.1)*.

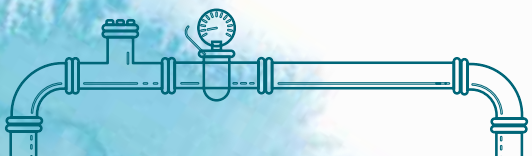


Table 4.1
Responsibilities in the SCMP

Source: JVA (2010a)

Responsibility	Organisation
Overall responsibility of implementation	JFDA/Food Control Directorate
Coordination of State Crop Monitoring Programmes	JFDA/Food Control Directorate Technical Coordination and Consumer Awareness Unit
Health inspector assistance during field sampling	NCARE (Extension Department)
Preparation of final report	Administration of Wholesale Market Amman
Results interpretation and overall evaluation	JFDA/Food Control Directorate Technical Coordination and Consumer Awareness Unit

In accordance with Guidelines of the *World Health Organisation* (WHO), SCMP focussed on microbiological, chemical and physical risks in treated waste water *(see Table 4.2)*.

At technical level, the project worked on building the technical capacities of farmers, JVA field staff and extension workers on safe and efficient use of treated wastewater in irrigation. To this end, on-farm risk management training modules for farmers and extension workers had been developed. The training modules served as an integral part of the SCMP. The capacity building aimed not only to minimize the negative effects of treated wastewater use but also to maximize the benefits from nutrients contained in this irrigation water. In addition, awareness campaign had been organized for local communities in the Jordan Valley to raise their awareness about main aspects related to use of treated wastewater.

At legal level, in light of availability of almost all effective risk management measures in the Jordan Valley whose effectiveness is also confirmed by the SCMP, the need arose to develop a national standard for irrigation water including marginal water. A Guideline for the SCMP for fresh vegetables produced with reclaimed water in Jordan was adopted as a national stand-

Vegetables	Parameters	Methods
Fruit (e.g. tomatoes, cucumbers, peppers)	Bacteriological parameter (e.coli, Salmonella)	Conducted according to international standards for sampling of fresh fruit and vegetables ISO 874/ 1980
Root (e.g.carrots, onions)	Heavy metals (Lead (Pb) and Cadmium (Cd).	The samples should be taken at the time of harvesting, mainly from two locations
Leafy (e.g. parsley, spinach, mint)	Nitrate for only Spinach and Lettuce	The large number of sampling sites can be covered over time by determining a number of sites for each sampling seasonw
Brassica (e.g. cabbage, broccoli)	Testing for Shigella was done for two years. JFDA decided to remove the Shigella testing out of the list, since there was no proof that Jordanian fresh vegetables might be contaminated with Shigella	JFDA/Food Control Directorate

Table 4.2
Overview of monitored parameters in the SCMP

Source: JVA (2010b)

ard in 2011 published within the National Plan for Risk Monitoring and Management System for the Use of Treated Wastewater in Irrigation. The regular monitoring of crops in the Jordan Valley which were cultivated with reclaimed water was executed up to 2012 by the JFDA to assure an independent implementation of the programme. The JFDA had been carried out sampling of fresh food and vegetables from 2006–2008 for the first time. However, their monitoring capacity within the initial reclaimed water implementation period was still modest and the system was not consequently implemented. GTZ supported the responsible institutions through capacity development activities, such as:

- training for inspectors (i.e. the staff responsible for sampling)
- training for laboratory staff
- seconding an expert to JFDA to help and train laboratory staff on the job
- improving the data transfer among authorities / publication.

4.4.2 Results and limitations

The need for a continuous and comprehensive large-scale sampling to ensure in a conservative way the safety of the crops and health of farm workers was agreed among all stakeholders and implemented. The controlled application of reclaimed water has opened the way for the installation of a comprehensive risk management for fresh fruit and vegetables in the Jordan Valley. It was assumed, that SCMP would contribute to protect the health of consumers and strengthening the marketing opportunities of Jordanian farmers. This assumption was confirmed by the SCMP results for the first four years. It was shown that the quality of treated wastewater-irrigated crops was in line with the international standard and consequently. Therefore, it can be concluded that the use of reclaimed water is a safe practice in the Jordan Valley.

SCMP was a key tool to promote the relevance of reclaimed water.

The SCMP was a key tool to promote the relevance of reclaimed water. However, until the end of the project, full institutionalisation of the SCMP was not achieved. The legal establishment of the SCMP is still pending, though in reality the programme is successfully implemented since several years. Reasons for the shortcoming are to be found in inter-agency coordination, such as the interaction between JVA and JFDA. JFDA executes various monitoring activities of controlling health relevant issues under the umbrella of the Ministry of Health. Most of these activities were financed by customers who need a certificate or permission. However, JFDA has the professional know-how, equipment and staff to execute the SCMP, but no official mandate and budget for this task. Between 2013 and 2016 JFDA was unable to execute the SCMP due to lack of financing. In previous years, the programme was financed by GTZ/GIZ. The MWI and JVA did not achieve the explicit division of responsibilities and a specification of SCMP's financing. MWI indicated to clear financing of execution of SCMP.

4.5 2010 ongoing: Supporting the use of Further Marginal Resources

Based on the success of the reclaimed water project, since 2010 GTZ/GIZ was supporting other approaches of valorisation of marginal resources with regard to:

- other sectors (greywater re-use in domestic wastewater management)
- other geographical regions (small-scale treatment plants in the Highlands with the use of reclaimed water in surrounding agriculture), and
- other resources (decentralized integrated sludge management).

4.5.1 Greywater Re-Use

Greywater is characterized as moderately polluted wastewater generated from domestic sources such as bathtubs, showers, sinks and washing machines. It mainly contains small quantities of detergents, oils, fat and solid particles, which can be easily removed by a variety of technical processes.

Greywater re-use can provide an additional decentral water source, which provides resources that can be used for gardening purposes or watering green spaces. That is why Government authorities with the support of GIZ started to get engaged in this topic. Experience with greywater systems in urban areas and particularly hotels were limited in Jordan, even though some systems, e.g. at the German Jordanian University, were already in place and operated smoothly.

GIZ's support to the re-use of greywater was part of the water program but financed by a particular funding basket from the German Government to strengthen *Development Private Partnership* (DPPs), i.e. tripartite partnerships involving the Jordanian Government, GIZ and a private sector partner from Germany. The idea was to transfer German technological know-how to countries, where this know-how is not yet available on the local market.

In 2010, a project with a focus on the application of greywater technologies in Jordan was initiated. The experiences made within this pilot project were meant to be used as basis for standards for greywater facilities. The goal was to scale-up the experiences and to guide the expansion of re-use of greywater in rural and urban areas.

Initially it was planned to consider a low cost and low maintenance approach and a complementary elaboration of a national standard for the application of greywater in urban areas. Three pilot projects were initiated in 2010 (Hotel Dead Sea Spa, a private house-hold and a mosque). In addition, some smaller interventions in schools and rural areas were implemented. The project financed the technology and accompanied these investments by training of potential water users (e.g. gardeners), planners of infrastructure (e.g. architects), maintenance staff and households. Furthermore, the publication and dissemination of standards to relevant government institutions was supported.

Promoted levels of greywater technologies did not allow promising levels of profitability for investors.

Results and limitations

Today, none of the GIZ-supported greywater installations provided the expected outcomes and all of them are shut down. The main reasons for the results are the economic framework conditions in Jordan's water sector. In general, the promoted levels of greywater technologies did not allow promising levels of profitability for investors, given the financial framework conditions of water supply in Jordan. This key challenge was encountered equally for small-installations in private households and for larger installations, for instance at the Dead Sea Spa or in big multi-purpose buildings in urban areas.

Operation and maintenance was another challenge. Staff of the Dead Sea Spa hotel was not able to conduct maintenance procedures as foreseen resulting in the halt of the operation after two years. The negative cost benefit ratio for the hotel impeded a repair of this installation.

Among the project partners (WAJ and GIZ), different opinions about the delegation of responsibilities for maintenance prevailed. Also within the donor community (especially between GIZ and USAID), perceptions about the most promising target group differed. These strategic differences made it difficult to come up with a coherent strategic approach of the Jordanian Government and the development partners.

Knowledge on greywater reuse in Jordan has increased with the project.

Nevertheless, the knowledge on greywater reuse in Jordan has increased with this project, and was summarized in a discussion paper on greywater use in Jordan from the water programme (GIZ 2011). Jordan's low water tariffs are restricting economic benefits of greywater use to areas where water is either expensive, e.g. tanker water, or where water access is very restricted as in some rural areas.

4.5.2 Decentralized Wastewater Management

It is predicted that by the year 2100 the precipitation patterns will change and average precipitation rates will drop significantly in the region as a result of climate change. This calls for a more intense use of all available resources, including and especially marginal resources. Currently, only around 62 per cent of households are connected to a sewage system. Most of the others use septic tanks. Seen from an economic and a technical perspective, the full coverage of households with central collection system is not possible. Therefore, a decentral approach including small waste water treatment plants are needed to complement to the central systems. Hence, there is significant and growing potential for the valorisation of these decentralised resources.

A decentral approach including small waste water treatment plants is needed.

The project "Decentralized Wastewater Management and Adaptation to Climate Change" started in 2015. The focus of the project is in the Northern Governorates that are strongly affected by the Syrian refugee influx and will suffer most from climate change. The project promotes efficient use of water resources by a twofold approach: groundwater resources are protected by reduced pollution from untreated wastewater. At the same time, treated wastewater is reused thus substituting fresh water. The project follows a threefold approach to promote decentralized wastewater management in Jordan:

- **Pilot demonstration of decentralized wastewater treatment plants and reuse systems for domestic wastewater:** In order to develop and test methods for reusing the treated wastewater in agriculture and landscaping, the decentralized wastewater treatment plants produce an effluent that meets the existing standard for treated domestic wastewater.

- **Preparation for scaling-up:** Apart from piloting, the project aims to support the sector in implementing the newly established Policy for Decentralized Wastewater Management. The underlying concept of the project in regards to scaling-up is the preparation of standardized decentralized wastewater treatment plants that only require adaptation to local conditions during the detailed design phase. To this end the project develops tools that enable project implementers to adapt the generic design, as well as to tender, construct and operate the plants.

- **Capacity development:** Piloting and the development of the tools are accompanied by strengthening capacities of stakeholders in the field of DWWM, incl. financing, designing, building, operating and maintaining such integrated systems.

Results and limitations

As the project started only in 2015, limited results on the ground can be observed until now. The project approach is plausible and addresses key challenges of the Jordanian water sector. It responds to the effects of climate change and builds on results of previous successful approaches. However, the construction of the pilot plant relies on external financing. To find financing solutions of investments and future operation still represent a challenge. The future implementation and operation of pilot plants has to face operational and financial challenges, which may endanger the development of this innovative and climate-relevant solution. Mainly the remote location will make it difficult to cover operation costs and maintain the plants properly.

4.5.2 Decentralized Integrated Sludge Management

Currently, there are about 30 wastewater treatment plants in Jordan. The largest, in As-Samra, treats more than 70 per cent of all the wastewater produced in Jordan. The other plants operate in smaller cities and communities throughout the country. While the sludge from As-Samra is utilised as an energy source through incineration, none of the other treatment facilities has a proper sludge management plan in place. At the plants that serve smaller communities, sludge is either disposed on the premises or transported to As-Samra. This is either an ecological or financial burden for WAJ that is running the plants.

None of the smaller treatment facilities has a proper sludge management plan.

The project "Decentralized Integrated Sludge Management", commenced in 2015 as part of GIZ's Water Portfolio, is financed by BMZ in the context of the *German Climate and Technology Initiative* (DKTI). This initiative aims at promoting German climate technology worldwide in order to reduce greenhouse gas emissions.

The project's approach focusses on three fields of intervention:

- Design, construct and operate pilot plant, including preparatory studies (potentials from mixed biomass, feasibility & business model, environ-mental, site selection, design, etc.), Design + commissioning
- Risk Management for applying new treated organic mix, Baseline, development and applying RM system, Building capacity in specialized testing of sludge and product
- Awareness raising among key stakeholders for sustainable sludge management incl. policy dialogue, Educational material / training for future applications, Case studies, annual meetings, etc.

The planned pilot plant will be constructed and managed by an experienced technology partner, relying on biogas production. Field testing of the produced organic substrate is planned to confirm the fertilizer quality and adequateness for agricultural production.

Within a redesigning of the initial project concept, the project focus on energy generation as a major project outcome was emphasized and land application of sludge was limited to the use in fodder production. This responds to the differing perceptions within Jordan in how far sludge can be used in land application. While agricultural standards allow the use of sludge only under particular conditions (on pastures in areas with an annual precipitation of less than 200mm), water regulations explicitly call for the re-use of the resource. The project is also active to inform and moderate this discussion.

The selection of an adequate approach should consider a set of multiple criteria and solutions, allowing the environmental sound disposal of sewage sludge and energetically optimized and environmental sound sludge treatment. This should comply with the climate change mitigation requirements on the one side and be economically justified, financially affordable for the responsible institutions or private stakeholders and respect public acceptance.

Results and limitations

The project is about to finalize its planning stage and will start the construction phase in 2018. The project approach is innovative and the co-digestion of biomass and sludge responds to two key environmental challenges in Jordan: the safe disposal of sludge and of domestic waste. An important

question for the project will be the cost-benefit ratio, i.e. who much energy can be saved through the pilot plant and whether that will economically permit the operation of the plant.

The legal framework in Jordan regarding the use of sludge is still sketchy.

One of the key expectations of the projects is that the digested biosolid will be used in agriculture. The legal framework in Jordan regarding the use of sludge is still sketchy and some Jordanian stakeholders have reservations to the use of sludge in agriculture. The project is informing the technical and political discussions for amending the existing standards. The current agricultural standard allowing for sludge in land application under particular circumstances resulted from these discussions.

In summary, it is too early to assess the project. However, the experience of the reclaimed water projects indicates that making the use of marginal resources generally accepted is a long way and difficult process.

4.6 Conclusions and outlook on the use of Marginal Water Resources

It was shown that GTZ/GIZ's support to the use of marginal resources started with a phase of regulating the existing practices of wild use of reclaimed water in irrigated agriculture the Jordan Valley. Trainings for farmers and the development of manuals, handbooks and standards let to a reduction of health and environmental hazards that went hand in hand with the unregulated use. At the same time, awareness campaigns helped to increase awareness for the benefits of the reclaimed water in agriculture.

A comprehensive risk management system is indispensable for an institutionalization within the Jordanian water sector.

These activities were successful and it became clear that for an institutionalization of reclaimed water as a key component within the Jordanian water sector, a comprehensive risk management system is indispensable. This was developed after 2006. The inauguration of the As Samra wastewater treatment plant in 2008 changed the quality of reclaimed water considerably requiring GTZ to adapt its trainings to farmers to the new conditions.

In a third phase, attempts were undertaken to scale-up the positive experiences from the reclaimed water projects in the Jordan Valley. These attempts either show disappointing results (greywater re-use) or are toe new to be assessed (decentralized wastewater management and decentralized integrated sludge management).

Key results and lessons learnt from these projects can be summarized as follows:

Acceptance of Reclaimed Water as a resource increased

In 2003, irrigation using treated wastewater was still regarded predominantly as "unpleasant". In 2008, the concept was nearly regarded as normal and routine. Efficient and safe use of reclaimed water was regarded by decision makers and farmers as the basis for sustainable agriculture in the Jordan Valley. The acceptance of the reuse of reclaimed water by farmers helped in avoiding or at least minimizing potential conflicts among different water user sectors (agriculture, domestic population, tourism, and industry). In addition, there was a new understanding among decision-makers that reclaimed water was an important element of water resources management.

Sustainability of Jordan's irrigation and agriculture ensured

The main benefit for farmers resulted in the continuous service of additional volumes of safe water for irrigation. Today, reclaimed water is the main resource for irrigation in the Jordan Valley. From 2005 to 2015, the amount of treated wastewater used in Jordan's agriculture (i.e. mainly in the Jordan Valley) increased from 80 MCM to 133 MCM (MWI 2015). It is clear that without the use of reclaimed water, agriculture would not be possible to the current extent. Therefore, the project had significant impact on food security and agricultural exports of Jordan. In addition, SCMP-campaigns in 2011/12 and 2012/13 confirmed the required quality of crops and stated that no important bacteriological contamination and other health risks were detected. Today, Jordanian farmers from the Jordan Valley are regarded as among the most advanced in the region because of their experience in using reclaimed water in a systematic and sound manner.

Scaling-up of experiences ongoing

Currently, the remaining supply gap for reclaimed water in the northernmost part of the Jordan Valley is to be closed. Germany's Development Bank KfW is financing huge investments in wastewater treatment plants in Irbid. The treated wastewater is channelled through a ring line connecting three plants in the surrounding of Irbid into the Jordan Valley.

Through the GIZ-implemented projects, institutional foundations for this scaling-up were laid. Guidelines and fertigation sheets as well as illustrated training materials are still in use by JVA. The use of reclaimed water is today

institutionalized in Jordan's legal framework, providing the necessary framework conditions for other development partners to support this topic.

An interesting scaling-up attempt beyond the Jordan Valley is implemented by GIZ in the project "Decentralized Wastewater Management and Adaptation to Climate Change" that started 2015. It attempts to implement similar approaches as in the Jordan Valley in the Highlands. This is highly necessary as groundwater resources for irrigation are dwindling. However, the economic conditions of decentralized wastewater management appear more challenging and it remains to see whether this approach will be successful. These economic conditions (low drinking water tariffs vs. high investment and operation costs) were also the main reason why the project approach regarding the re-use of greywater did not succeed.

Institutionalization of project results required

A weakness related to sustainability of project results is that the financing of the SCMP is still not ensured. This impeded the implementation of the programme since 2013. This is a thread as a health hazard may damage the reputation of reclaimed water as a safe resource for agricultural production.

Institutional learning processes

During GIZ's support to the Jordanian agricultural sector, the involved institutions traversed an iterative learning process that laid the foundations for the valorisation of marginal resources. Key elements supported by GTZ/GIZ in this process were the development of standards for the use of marginal resources in agriculture as well as the development of a comprehensive risk management systems.

The brackish water project served as a starting point that proved the relevance of the developing and implementing specific guidelines for the use of marginal water. Through these guidelines, the already ongoing use of marginal water in irrigation was formalized and supervised by the competent public authorities. This approach was pursuit in the following projects on marginal resources (reclaimed water, decentralized wastewater management and decentralized sludge management). All projects put a focus on the development of necessary standards and guidelines to allow the Jordanian institutions to carry on the use of marginal resources after the pilot activities of the projects are terminated.

The setting-up of the SCMP was crucial to prove scientifically and demonstrate publicly the safety of the agricultural products. This was a key for scaling-up the use of marginal resources and replace considerable amounts of freshwater by marginal water. Also, it opened the way to the use of new marginal resources, such as sludge, though the use of this resources is still in its infancy.

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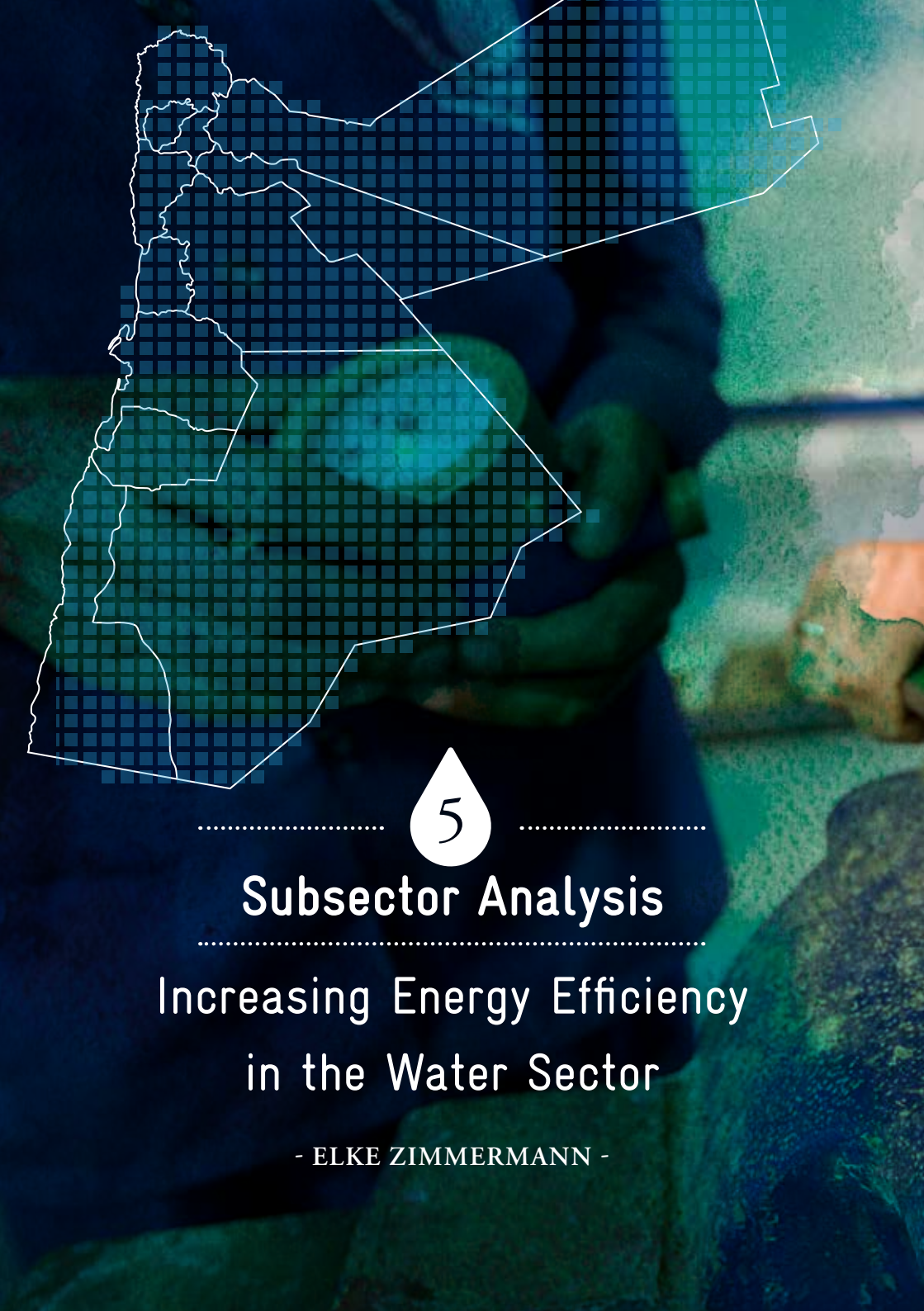


5

Subsector Analysis

Increasing Energy Efficiency in the Water Sector

- ELKE ZIMMERMANN -

5.0 Increasing Energy Efficiency in the Water Sector

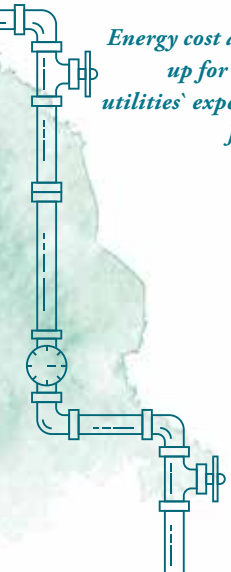
Elke Zimmermann

5.1 Challenges

Jordan's water sector faces numerous challenges of which increasing scarcity is the most prominent one. This chapter is focusing on energy intensity, which is closely associated with managing water scarcity: The production cost of water increases when remote sources are tapped and extensive treatment is required. Next to increasing fixed cost, such as higher investments, variable cost for water production rise considerably. Accounting for around 50% of the utilities' expenses, energy is the main cost driver of water supply. Being scarce of own fossil resources, costly energy imports limit the economic feasibility of water utilities.

5.1.1 Declining (Renewable) Water Resources, increasing demand

Jordan is overusing its limited water resources due to economic development, increasing living standards and high population growth. The latter is dominated by the high influx of refugees induced by the Syrian crisis. According to Unicef and based on the latest Jordanian Census of 2015, the population has doubled between 2000 and 2015 from 4.76 M to 9.5 M inhabitants (UNICEF 2016).



Energy cost account up for 50% of utilities` expenses in Jordan.

The share of renewable water resources per year dropped to merely 57 m³ per capita (KfW et al. 2016). To respond to the increasing pressure on water supply, new water development projects are realized. Remote groundwater bodies are tapped, which increases the energy intensity of water production (MWI 2016a, GIZ 2008). Dynamic water levels are currently dropping by up to 20 meters per year and deeper wells have to be drilled. Larger volumes are transported with higher pressure through an undersized network in a topographically challenging terrain (GIZ 2014a, GIZ 2014b). Next to the exploitation of freshwater resources, water development strategies aim to further increase the share of reusing treated municipal wastewater in agriculture and industry to cope with rising water demand. Therefore, the WAJ invests in new sanitation infrastructure and increases the capacity of existing treatment facilities. Currently, 31 wastewater treatment

plants are in operation and 91% of the municipal wastewater is reused mainly in agriculture (MWI 2008, MWI 2014). The amount of treated wastewater will increase within the next ten years by around 10%, which equals to additional 94 MCM per year (MWI 2016b).

Aside from ever increasing demand effects, climate change will further reduce renewable water supply. It is expected that in the next centenary temperatures will rise by 1–4 °C while precipitation will decrease by approximately 15–60% (GIZ 2013b). Increased evaporation induced by higher temperatures and decreased rainfall will reduce groundwater and surface water recharge while extreme weather events will occur more frequently, further reducing the renewal rate of groundwater by 30% (MoEnv 2015, KfW et al. 2016).

5.1.2 High water production cost and low-cost recovery rates

Exploiting scarce water resources results in high water production costs. The challenging topography with elevation differences of 1,200 m in the network, the spatial distance between resources and demand, fragmented settlements, abrupt rise in demand due to Syrian crisis, exploitation of deeper and remote water resources, and increasing reuse lead to high investments in water infrastructure as well as high water production and transportation cost.

Today, a network of about 200 pumping stations delivers water from 650 wells to water subscribers. To meet the increasing water demand of population centres and refugee camps in the middle and northern governorates, water is increasingly supplied from groundwater aquifers located in the far South and East. Water is pumped from the Disi aquifer over a distance of more than 300km to Jordan`s capital and further North (GIZ 2016a).

High water production costs of JOD 1.844 per m³ (2013) are facing subsidized water and wastewater tariffs of JOD 1.058 (average), and consequently generating a deficit for the utility of JOD 0.786 for each m³ produced. This leaves WAJ with a total deficit of JOD 154 M per year from water production only. Taking high investments, debt services and support of under-performing utilities into account, total indebtedness (internal and external) of WAJ has increased from JOD 430 M (2008) to JOD 1,000 M in 2013 and M 1.616 JOD in 2016 (MWI 2016b).

Increasing cost for water production are accompanied by subsidized water tariffs, high rates of non-revenue water, and rising cost for energy.

Despite considerable efforts in recent years in rehabilitating infrastructure and reducing administrative losses, cost recovery rates actually declined from 72% in 2009 to 56% in 2013 (MWI 2013). Main drivers are the increase in electricity tariffs and the commencement of Disi Water Conveyance project (MWI 2016b). The Disi Water Conveyance project sells in a *Build-Operate-Transfer* contract (BOT) water at a fixed rate of JOD 0.9 m³ to the WAJ. WAJ subsidies on Disi water alone reaches up to at least JOD 95 M annually (EIU 2013).

On average, 52% of the already subsidized water pumped into the distribution lines are not accounted for (KfW et al. 2016). In some governorates, the *Non-revenue-water* (NRW) rates are estimated well above 70%.

Ailing infrastructure with an average age of 25 – 50 years is a key factor for high NRW rates in the Kingdom. Pipework ages particularly fast in Jordan due to intermitted water supply schedules (water is regularly supplied every 4 – 20 days, depending on zones and potential rationing during the summer months). Related pressure changes in the network contribute considerably to high NRW rates. Further, (emergency) repairs, based on incomplete network plans, using inappropriate replacements and materials are often done rather ad-hoc then preventive. Other main drivers for high NRW rates are declining morality of payments among customers, water theft and eventually inaccurate metering (GIZ 2014b).

Considerable infrastructure investments to increase water supply, high NRW rates and increasing energy cost are facing low water tariffs. As a consequence, the ratio of total cost coverage dropped in recent years. Numbers would be even lower, if hidden existing subsidies like electricity for water pumping and sufficient expenditures for operations and (preventive) maintenance would be considered in cost recovery calculation (MWI 2016a). Aside from inefficiencies in water production due to inadequate equipment and operation, unaccounted or lost water resources dramatically influence the energy balance of the Jordanian water sector.

5.1.3 Increasing energy demand and increasing energy tariffs

Overall annual growth rates for Jordan`s energy demand, which is prospected until 2025 with 4 – 5% for primary energy and 5.3% for electricity, is one of the highest in the world. Consequently, securing energy supply –

technically and financially – is considered as one of the country`s most significant development challenges (MoEnv 2015).

Being scarce of own fossil resources, Jordan satisfies more than 96% of its energy demand (World Bank 2016a) through imports. This accounts for almost one-fifth of the *gross domestic product* (GDP), which makes the country completely reliable and, as a consequence, also vulnerable to the global energy market developments (MoEnv 2015).

Although the electricity bill is still subsidized by 60%, electricity cost contributes up to 50% of the water utility`s total operating expenses.

The water sector shows even higher growth rates. With 14% of the overall national electric demand the water sector is the biggest single national consumer: Sector-wide 1,424 GWh were consumed in 2014, which equals, based on Jordan`s fuel mix in electricity production to approximately 755,000 t CO_2 (MWI 2016a, GIZ 2014b).

Although the government subsidizes the water sector`s electricity bill by approximately 60% (MWI 2015), electricity costs still contribute up to 50% of the water utilities' total operating expenses.

Aside from increasing water supply, the volumes of treated wastewater increased, partly due to growing water demand, but also due to achievements in connection rates *(see Fig. 5.1)*. To respond to higher volumes of wastewater and necessary treatment, WAJ increased the capacity of existing wastewater treatment plants and developed new treatment facilities. As a consequence, expenditures for water treatment increased as well as the energy intensity of water supply and sanitation.

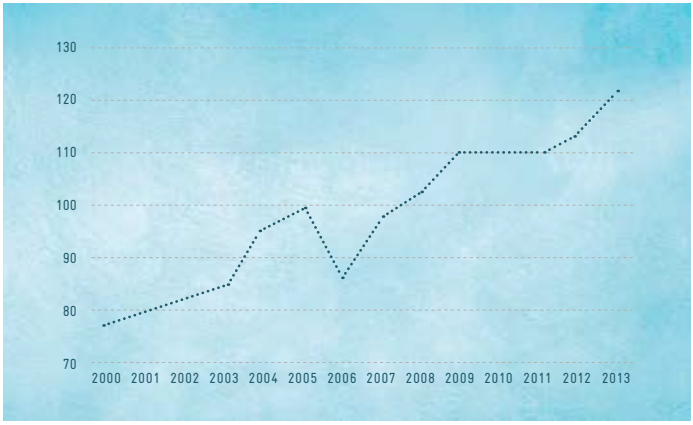


Figure 5.1
Volume of Treated Wastewater in MCM

Source: MWI (2013)

Utilities face dramatically increasing energy cost not only due to the need of supplying and treating higher volumes of water, but also due to increasing tariff *(Table 5.1)*. Starting from 2013 the cost for electricity is supposed to almost double until 2017 according to the National Electric Power Company and eventually phase out subsidies (KfW et al. 2016).

Table 5.1
Tariff of electrical energy for water pumping and sewage treatment owned by WAJ

Source: MWI (2013)

Year	2nd half 2013	2014	2015	2016	2017
JOD for each kWh sold	0.076	0.087	0.100	0.115	0.133

According to WAJ estimates of 2013 each cubic meter of water requires about 2.8 kWh to be delivered to consumers (MWI 2015). If one would assume a constant electricity consumption, and a tariff increase of 2 % annually, the electricity bill of the water sector will increase in the next 20 years from JOD 190 M in 2015 to JOD 354 M in 2034 (MWI 2013). Even in a business-as-usual scenario the energy costs for the water utility will most probably show a more dramatic increase and hence be a considerable burden to WAJ.

5.1.4 Low O&M Capacities and Practices

A lot of equipment, which did not necessarily meet the hydraulic and energetic requirements was installed.

Low level of qualification together with staffing procedures intensify poor installation and service capacities in the water sector. Consequently, weak maintenance and operational skills, missing training and awareness, as well as information deficiencies to run facilities in an energy efficient manner result in higher energy consumption. The prevailing practice of delayed or sometimes inappropriate maintenance further contributes to an increase of the sector's energy intensity (World Bank 2016b).

Ad-hoc and emergency repairs as well as the financial difficult situation of water utilities together with a "one fits all" spare part policy lead to installation of equipment, which does not necessarily meet the hydraulic requirements. Procurement and tendering procedures of WAJ only partly consider criteria of life cycle costs. Consequently, cheaper materials and equipment are purchased, which do not necessarily meet the technical requirements of the specific water infrastructure, result in higher energy cost and will have to be replaced more quickly (GIZ 2009a).

As a consequence, existing wells and booster stations sometimes show very high energy demand curves due to inappropriate equipment and operation schemes. Manual operation schemes like throttling of pumps lead to constant energy inefficient operation and fast ailing of material (GIZ 2009a). The saving potential of all pumping stations was estimated in 2013 to sum up 1.038 GWh per year, which equals to 755.000 t CO_2/a (GIZ 2014b). Aside from ailing infrastructure, the sector`s weak O&M capacities are a main obstacle for sustainably reducing NRW rates next to illegal water use and hence intensify the sector`s energy demand. NRW rates of more than 50% consequently more than double the energy intensity of water delivered or treated.

In addition, the increase of water- and wastewater subscribers due to the Syrian crisis influenced greatly the hydraulics; the overall system of water supply and sanitation is partly outdated and needs further restructuring and reinforcement to cope with changing requirements (GIZ 2014a).

5.2 The Potential

Reducing the energy intensity of the water sector can follow a number of different approaches. Financial restructuring and debt management along with improving cost recovery rates, tapping alternative energy sources, improving inefficient practices and equipment, rehabilitation of water networks and herewith reducing NRW are all measures that can improve the energy efficiency. In addition, energy can eventually be generated or recovered from water supply and treatment facilities, which will positively influence the (fossil) energy balance of water supplied or treated.

German bilateral contribution aimed to reduce the electricity demand of the water sector through energy efficiency measures by 100 GWh per year.

The GIZ supported and supports the Jordanian water sector in a multilevel approach through policy advice, piloting energy efficient equipment, enhancing energy efficient O&M procedures, involvement of private sector experience, and the collection and use of biogas on wastewater treatment plants, as well as in vocational training and capacity development. As per the current programming, the German bilateral contribution aims at reducing the electricity demand of the water sector through energy efficiency measures by 100 GWh per year, with an energy consumption of 2076 GWh in 2013 as a baseline. (KfW et al. 2016).

5.2.1 The role of Development Cooperation in improving Energy Efficiency

Water utilities firstly did not pick up on the topic internally due to institutional barriers and pressure on the actual day-to-day operation.

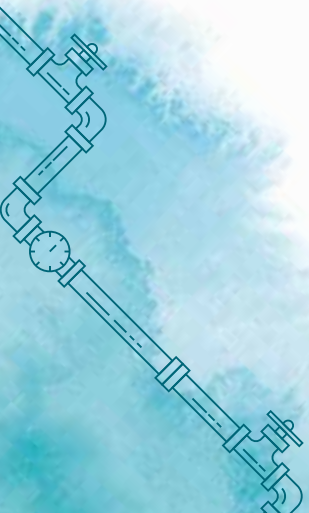
The challenges highlighted in the previous paragraphs already give an indication on the potential of energy efficiency measures in the Jordanian water sector: Operational cost for the water utilities can considerably be cut down, releasing financial means for example water infrastructure rehabilitation and extension or improving cost recovery rates. Anticipating the forecasted further increase of energy tariffs and water demand alike reducing the sector`s energy intensity might be inevitable.

As one of the first measures to be undertaken in the field of energy efficiency in Jordan`s water sector, GIZ together with KfW supported WAJ to conduct a baseline assessment for water pumping in 2009. The energy audit revealed an energy saving potential in the middle governorates for pumping stations alone of more than 30% (GIZ 2009b).

Potential energy savings of about one-third in average presumably provides investment opportunities, which will result in cost savings outweighing the investment required. Mainstreaming energy efficiency not only to pumping stations but to water infrastructure in general will noticeably cut down operational and energy expenses for the water utility.

Despite the identified considerable saving potential, the water utilities firstly did not pick up on the topic internally. Institutional barriers and pressure on the actual day-to-day operation of water supply prevented a nationwide outreach at first.

Due to water scarcity, subsidies and ailing infrastructure Jordanian utilities usually focus rather on securing water supply than on cost-efficient operation. In particular during summer, the maximization of production might be the sole focus of utilities` operation patterns. Corresponding to the focus on supplying sufficient water to the customers repairs and maintenance processes are often ad-hoc rather than preventive and show low quality of works. Installed equipment are often inappropriately designed and operated. This practice leads to particularly fast aging of material and equipment and, as a result, again a high frequency of replacement and repair (GIZ 2009b).



This inappropriate practice leads to high life cycle cost since pumps have to be replaced frequently and are operated in an energy intense manner. WAJ, being a public institution, has strict tender procedures for procuring technical equipment. Until the beginning of energy efficiency measures in Jordan, procurement specifications did not consider life cycle cost nor operational cost over the entire lifetime of technical equipment (GIZ 2009b). Overall, compared to the challenges in day-to-day water supply induced by scarcity energy was not of highest priority in decision making. Since (subsidized) energy is paid centrally through WAJ to the national electricity company, the actual operation of infrastructure is not made responsible for eventually high cost of water production.

Another major challenge to introduce equipment capacities in O&M of such equipment were not available. In addition, incentives for improving management and processes, such as treating water infrastructure as cost centres or linking the operator`s performance to sector specific objectives were not in place (GIZ 2009b).

WAJ, being a loss-making public entity, was not perceived as a reliable business partner by the private sector. Next to insecure payment practices, missing experiences with performance-based contracts did discourage private companies to engage in business relationship and liabilities with Jordan`s utilities (GIZ 2009b). The provision of an objective and reliable data base through GIZ, as well as taking the role as mediator and good broker was key in formulating baseline agreements and support in negotiation rounds. To build up mutual trust in the respective business partner as well as in the concept of energy performance contracting, the presence, role and standing of GIZ project staff was safeguarding and enabling energy performance contracting in the water sector.

In the light of the challenges mentioned above, the aim of development cooperation was not only to demonstrate financial feasibility of energetic refurbishment of pumping stations but also to develop contractual models to allow upscaling and access to finance through the involvement of the private sector. Further, institutional restructuring to allow for lifecycle cost considerations and capacity development to localize technology sustainably in Jordan are main objectives of development cooperation. The development cooperation`s objectiveness, and role as a reliable and trustable mediator was key in negotiations and in establishing energy performance contracting as a new field of business opportunities for both, the private and public sector.

The GIZ role as a reliable and trustable mediator was key in negotiations and in establishing energy performance contracting.

5.2.2 Timeline of German Support to reducing the Energy Intensity in the Water Sector

The potential of energy efficiency for Jordan`s water sector was presented through GIZ during the official visit of H.E. Mr. Gabriel, former Minister of the German Ministry of Environment, Nature Conservation and Nuclear Safety in 2006 and received therefore further attention. Based on an already existing pre-assessment of pumping performance at Ebqoriyeh pumping station (through the "Operation and Management Support" project) a project proposal to showcase energy efficient operation of water infrastructure and its beneficial impact on emission reduction was agreed upon. The very first project sketch received additional momentum once the German Ministry of Environment, Nature Conservation and Nuclear Safety dedicated funds under the International Climate initiative in 2008. As one of the first projects funded by the International Climate Initiative the project "Improving the Energy Efficiency of WAJ" was creating the base for German development cooperation`s increasing portfolio aiming at reducing the sector`s energy intensity in Jordan.

The following *Fig. 5.2* gives an overview on the timeline of implemented measures as well as on the prominence of energy efficiency in the respective measure`s objective.

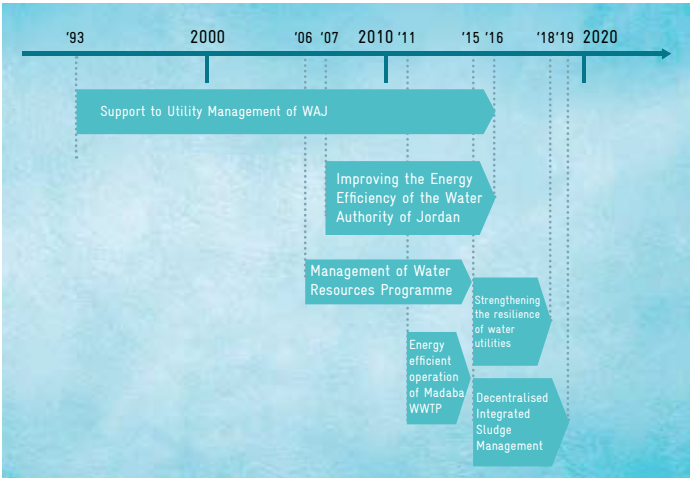


Figure 5.2
History of reducing energy in German-Jordanian Cooperation

Source: Own compilation

The following paragraph is elaborating in more detail the sequence and different stages of project activities and implemented measures in the field

of improving the energy efficiency in the Jordanian water sector through German-Jordanian cooperation.

5.3 2006: Preparing the ground for Improved Energy Efficiency in the Water Sector

Despite the huge potential energy efficiency was not dominating the agenda of WAJ until late 2000. Operational procedures did not consider energy efficiency parameters due to subsidized energy tariffs and the sole focus on securing water supply through maximizing of water production. In addition, required equipment to measure infrastructure-specific energy consumption was not available nor data recorded.

5.3.1 Approach: Energy audit and establishment of baseline

Since hydraulic data on pumping performance and energy losses in networks were not yet available, a comprehensive energy audit was undertaken as one of the first measures in the field of energy efficiency in Jordan`s water sector. Based on the collected data a baseline assessment for 25 pumping stations and well fields in the middle governorates was conducted in 2009 containing pumping efficiency, saving potential an investment need forecast.

Based on technical and financial assessments the Ministry was supported in project and policy formulation and intervention design to strategically develop energy efficiency in the water sector. WAJ was supported in creating an energy efficiency task force at WAJ to create awareness and mainstream the topic of energy efficiency in relevant national sectoral strategies and policies.

Together with the tender department at WAJ tender specifications were revised and sample terms of references developed, which reflect energy efficiency criteria and life cycle cost in their specifications. Based on investment and operational cost estimations suitable business and contractual models were developed. WAJ was supported in logging and assessing data required for energy contracting and outsourcing models as well as in match-making with potential contractual partners from the private sector (GIZ 2014b).

5.3.2 Results and limitations

The energy audit revealed an average energy saving potential for pumping stations of at least 30%

Assessment of Energy Efficiency Potential

The assessed water infrastructure in the baseline study accounted for 70% of the overall energy demand of WAJ in the middle governorates. The energy audit revealed an energy saving potential for pumping stations between 4% – 65% and with an average of approximately 30%. The assessment estimated that through energy-efficient operation of the selected pumping stations the energy use can be reduced by 21.4 M kWh or approximately 15,700 t of CO_2 emissions per year. With the still subsidized energy tariff of JOD 0.043 per kWh in 2009 estimated savings of about JOD 1 M per year were estimated, which equals to a pay-back period of 4 – 14 years depending on the energy efficiency savings potential of each pumping station (GIZ 2009b). Recently increasing energy tariffs shorted the respective payback period dramatically.

Due to the promising results of the baseline assessment for the middle governorates a nationwide energy audit was undertaken to estimate the energy saving potential of pumping stations. Based on an approximate analysis a shortlist and a comprehensive assessment of pumping stations showing highest energy saving potential was developed. Assuming the energy tariff of 2013 annual potential savings of 3,3 M EUR were estimated. The saving potential for wellfields alone was 13,59 GWh/a equalling 9.877 t of CO_2. The rehabilitation of selected networking station would result in 28,51 GWh and 20.760 t CO_2/a respectively. In total, accumulated savings are estimated to be 42 GWh or 30.637 t CO_2 annually, which would reduce the overall energy consumption by 33,5% (GIZ 2014b).

Improvement of Tendering Processes of Energy Efficient Equipment

The project "*Improving the Energy Efficiency* of WAJ (IEE)" supported the tender department at WAJ in revising and optimizing tender procedures and documents to allow for procurement of energy efficient equipment. Before consultation, the tender procedures did not consider lifecycle cost and energy efficient measures in the description of services and technical requirements. Former project counterparts confirmed that energy efficiency aspects and life cycle criteria are since the IEE project considered in procurement processes for pumps and eventually also other equipment and tendering documents and developed Terms of Reference are still used and referred to. Further, the latest water strategy foresees now "Investments that take into account the life-cycle cost of a water or sanitation improvement or

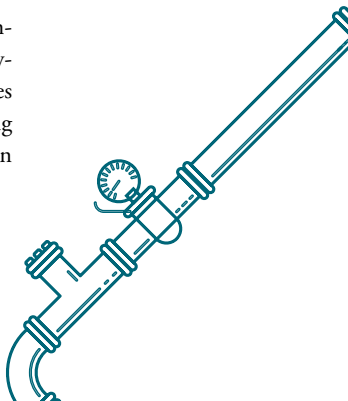
that are specifically directed at the maintenance and operation of new and existing services are essential to avoid backsliding. MWI and WAJ will develop and implement an asset management plan to guide expenditures on operations and maintenance and capital investments "(MWI 2016a).

Mainstreaming of Energy Efficiency in Policy Making and Scaling Up
To follow up on gained experiences in energy efficiency during project implementation WAJ formed an energy efficiency department. Through that committee, the topic of energy efficiency was mainstreamed in most relevant national sectoral strategies and policies (GIZ 2014b):

The National Water Strategy 2016–2025 aims to reduce technical inefficiencies in energy use as well as in energy efficient O&M practices in the water and wastewater sector. Further, the overall energy demand of the sector shall be reduced by 15% until 2025. Reducing the financial losses and herewith improving the sectors cost recovery is part of the "IMF action plan" Jordan and the International Monetary Fund agreed upon in 2014. As reflected also in the *Intended Nationally Determined Contribution* (INDC) the increase of water and wastewater tariffs, the reduction of energy intensity, and increasing the share of renewable energies in the energy mix are part of the intended actions. Jordan published a National Climate Policy for 2013–2020 in which the water sector is identified as a key sector for mitigating GHG emissions though improving energy efficiency in the field of water and wastewater (KfW et al. 2016, MWI 2016a, MoEMR 2007). The National Strategy for Employment and Vocational Training 2014–2020 targets capacity development and training particularly in the field of energy efficiency, renewable energies as well as the water and wastewater sector.

5.4 2007–2016: Showcasing economic and technical feasibility

Despite the rising awareness on the potential of reducing the energy intensity in the Jordanian water sector, missing examples on the ground showcasing the technical and economic feasibility of energy efficiency measures were still a major obstacle for a sector-wide roll-out. Aside from missing proof of performance of costly energy efficient equipment capacities in O&M were not yet available (GIZ 2009a).



In addition to technical and operational capacities, managerial and contractual capacities also had to be established at the institutional level. However, in regard to outsourcing models, WAJ could build on recommendations and lessons learned from previous phases such as the promotion of private-sector cooperation projects through OMS.

5.4.1 Approach: Introducing the market through Energy Contracting Models

In regard to outsourcing models, WAJ could build the promotion of Micro-PSP projects on recommendations and lessons learnt.

The concept of performance-based contracting models for increased energy efficiency in the water sector was new to Jordan. Consequently, capacities in setting up contractual documents based on key performance indicators and sharing agreements were missing. In addition, the trust in WAJ`s ability of payment morale was limited. Further, missing local aftersales service structures, O&M capacities, as well as market knowledge and data lead to hesitations of technology providers to invest in the Jordanian water sector. Measurements on energy saving potential in selected pumping stations including logging of required technical data created the base for implementing a demonstration project in energy efficiency. Business cases with corresponding contractual models were developed and suitable partners from the private sector willing to engage in a Built-Operate-Transfer commitment with WAJ were identified.

The first pilot demonstration project In Ebqoriyeh was a BOT contract simulating energy performance contracting.

In a two-stage approach the concept of energy performance contracting was introduced: The first pilot demonstration project In Ebqoriyeh, a small pumping station in Balqa governorate, was a contract between WAJ, a local engineering company and an international technology provider. This approach can be seen as a simulation of a BOT contract, with no financial payments from WAJ and – due to GIZ's involvement and contribution of 50% of the total project cost – a limited risk for the private sector. Based on the analysis of the energy audit, the pump manufacturer delivered and installed high-efficiency pumps. The local private company took over the O&M including training of WAJ seconded staff at the pumping station. Installed measuring equipment was logging energy consumption and pumped water volumes, hence the savings throughout the project phase could be calculated in an "as if" energy contracting scenario. In the first project, financial means and eventually project risks were shared between the contractual parties, consisting of the local private sector, the manufacturer, WAJ and GIZ. Based on lessons learnt and experiences made in the

first pilot installation, monitoring and contractual arrangements the concept of energy performance contracting were refined and developed together with the Jordanian counterpart.

In a second demonstration project at Wala and Libb, two pumping stations in Madaba governorate, the financial investment was covered by the private consortium. The consortium, again a local engineering company with O&M experience and an international pump manufacturer signed an energy performance contract with WAJ, which included a refinancing agreement of investment through generated energy savings.

Energy performance contracting, being already widely used in Europe was a relatively new concept to the Middle East and almost unknown in the water sector. Through the two-stage approach not only the technical and economic feasibility of energy efficient equipment could be demonstrated but also the contractual arrangements of energy performance contracting were showcased for the first time in Jordan (GIZ 2014b).

A third project demonstrating the economic advantages of energy efficient management processes was introduced at Madaba wastewater treatment plant. A local engineering company signed a cooperation agreement together with WAJ and an international wastewater technology provider. The aim of the project was to reduce energy consumption at the wastewater treatment plant through improving O&M capacity as well as energy efficient management of sludge.

Furthermore, the projects supported the national strategy of improving and enabling national capacities in the field of energy efficient O&M of water infrastructure (GIZ 2014b). In addition to specific trainings designed to operate particular project infrastructure (e.g. pumps, sludge treatment) capacities are developed through sector wide support of vocational training centres. GIZ is supporting the Vocational Training Centres in setting up and executing training programs to provide water utilities and private sector alike with skilled staff in the field of energy efficient O&M of water infrastructure.

5.4.2 Results and limitations

Assessment of financial resources and realization of potential at scale
By involving the private sector through BOT-based contracts additional financial resources could be acquired for the public sector without taking over any commercial risk. When engaging in energy contracting models, the utility receives shares of achieved savings from the start of the project and is handed over a fully refurbished facility with trained O&M staff at the end of the project (GIZ 2014b). Considering the numerous challenges Jordanian utilities are facing combined with low cost recovery rates, access to finance is indispensable.

By demonstrating technical and economic feasibility of energy efficiency in the water sector, the concept was quickly picked up by other institutions in the development cooperation (e.g. KFW, EBRD), which increased the dedicated financial means for energy efficiency in Jordan`s water sector (Governmental Negotiations 2016). However, due to prevailing risks related to security of payments through WAJ as well as hesitations of engaging in long contractual engagements with the public partner the scaling-up potential cannot yet be exploited fully. In addition, being a new business opportunity capacities and experiences still need to unfold and develop further (KFW 2016i).

Recently, water infrastructure with highest energy saving potential were refurbished directly through WAJ and often financed through financial cooperation loans and grants. Despite being potentially attractive to the private sector for energy performance contracting the momentum was not picked up. Interviews with decision makers at MWI indicated that development cooperation can be somewhat inconsistent to joint objectives: Efforts and achievements made by the technical cooperation in regard to private sector participation are demounted by financial cooperation by boosting financial means dedicated to procurement of energy-efficient equipment without putting enough attention towards improving O&M capacities at the same time.

Private Sector Mobilization and introduction of Energy Contracting Models
According to the MIW, the OMS project is considered the founder of commercialization of water utilities in Jordan. Through introducing the concept of private-sector involvement and energy performance contracting first experiences and lessons learnt could be generated and used for man-

agement contracts later on. Aside from benefits generated for the utility, Jordanian companies did benefit from piloting projects and contracts. Being mainly active as engineering consultants, the field of managing and financing water infrastructure potentially creates new business opportunities for local companies. Through demonstrating economic and technical viability the private sector did gain expertise, trust and willingness to take over commercial risks and develop competencies as ESCOs. With the energy performance contract at Wala Libb pumping station, the first commercial performance-based contract was introduced to the Jordanian water sector. By piloting not only energy efficient technology but also contractual models, business and financing opportunities could be demonstrated to both, the private and the public sector. Despite prevailing risks and constraints, in particular the local private sector is picking up the momentum. According to KFW, around 30 contracts are concluded with the local private sector, either as a main or sub-contractor. However, a recent law suit between the contractual parties of the performance based contract shows, developing and improving contractual documents further is a necessity and logical consequence in the learning curve for private sector participation in the Jordanian water sector.

With the energy performance contract at Wala Lib pumping station, the first commercial performance-based contract was introduced to the Jordanian water sector.

Saving costs and reducing CO_2 emission

Energy audits revealed that energy-efficient equipment reduce electricity consumption sustainably and are, taking life cycle analysis into account, economically more feasible. By improving the cost recovery of the water utility financial means are spent more efficiently and can reduce governmental subsidies. During the last years GIZ installed energy-efficient equipment and trained operators in energy-efficient O&M procedures at three pumping stations and one waste water treatment plant in Jordan. Through the implemented measures energy could be saved and hence emissions reduced.

At Madaba wastewater treatment plant, energy efficient management resulted in JOD 55.000 (25–30% reduction) energy savings per year and the elimination of transport cost of treated sludge of approximately JOD 94.000 annually. The project was realized through a development partnership with the private sector with overall project cost of about EUR 420.000 (GIZ 2013a).

The pilot project in Ebqoriyeh focused on improving the energy efficiency in water pumping. Energy consumption dropped by 33% through the

installation of energy -efficient equipment and improving O&M procedures. The reduction from 1,73kWh/m³ to 1,15kWh/m³ water pumped results in approximately 1,5 GWh and 65.000 EUR savings per year, which equals 1,100t of CO_2 emissions (GIZ 2014b).

Installation of energy-efficient equipment and improving O&M procedures through an energy performance contract resulted in the reduction of energy consumption by 3.6 GWh per year at Wala and Libb pumping station which equals a reduction of JOD 313,000 in energy cost and 2,500 tCO_2 reduced emissions per year (Tiltaria 2016).

Overall, implemented pilot installations demonstrated the proof of concept and showed the technical and economic feasibility of improving the energy efficiency at both, water pumping and waste water treatment. Aside from positive effects on climate protection investments are economically highly feasible. Through the applied concept of energy performance contracting the water utility did receive shares of generated savings at the pumping stations right from the beginning of the project and an additional source of income was generated for WAJ.

5.5 2016 ongoing:upscaling Energy Efficiency

Reducing the energy intensity of the water sector is of highest importance to the sector and dedicated political will.

Through demonstrating the technical and economic feasibility of energy efficiency measures in the Jordanian water sector together with developing and applying energy performance contracting models the base for a future sector wide roll out was created. Business and financing opportunities could be demonstrated to both, the private and the public sector. Despite prevailing risks and constraints, in particular the local private sector was picking up the momentum.

Overall, reducing the energy intensity of the water sector by improving the energy efficiency and using alternative sources of energy is of highest importance to the sector and dedicated political will.

Until today, the concept of energy performance contracting is only applied at pumping stations in the water sector. The potential of reducing the energy intensity in other water infrastructure is huge recalling the increasing energy cost and demand for water supply and reuse.

Experiences made during piloting energy efficiency equipment together with O&M revealed that capacity development is key to successful and sustainable project implementation and continuation.

5.5.1 Approach: Mainstreaming Energy Efficiency throughout the Water and Sanitation Sector

The topic of energy efficiency is mainstreamed in national policies and strategies and consequently part of bilateral development cooperation projects. But implementation of the ambitious policy and strategic targets has not been unfolding as swiftly as hoped. GIZ consequently picked up on the lessons learnt and recommendations from the first experiences of energy efficiency measures in Jordan's water sector. Human capacities will be developed through intensifying efforts in vocational training and training for specialized staff. The managerial level of the ministry will be supported in energy-efficient planning and asset management (KfW et al. 2016).

The new phase of the water programme aims to broaden the achievements of the energy efficiency projects and will further support measures in the field of energetic use of sludge and wastewater (Governmental Negotiations 2016). Reducing NRW, as well as increasing the cost coverage, and hence the economic viability of Jordanian utilities, is the aim of the project "Strengthening the resilience of Jordanian water utilities", which will further demonstrate energy efficient technology at selected water infrastructure in refugee-hosting communities.

To improve energy-efficient O&M procedures and ensure the sustainability of installed technology, all implemented measures do contain capacity development and training activities. Aside from trainings on-the-job as well as on-site through seconded staff or external experts, materials and curricula are developed, and where management contracts were involved, the private off-taker did train seconded staff on the respective technology on-site throughout the entire contract duration. Additionally, employees of the technical department are supported and trained in identifying energy efficiency potentials and formulation of project proposals to approach potential funding organizations. In addition, study tours with decision makers to fairs, conferences and energy-efficiently managed project sites were undertaken (GIZ 2014d)

5.5.2 Results and limitations

Overall, GIZ`s support during the last decade to reduce the energy intensity of the Jordanian water sector by improving the energy efficiency and using alternative sources of energy is highly appreciated by the political counterpart. GIZ activities in the field of energy efficiency and energy intensity range from pilot installation to macro-level policy advise. Some projects are already closed and can be evaluated against their benchmarks indicated in respective project proposals. Others are still ongoing and impacts can only be forecasted.

Reaching out and scaling up

Although picked up by other international cooperation organizations and eventually scaled up to other sectors, GIZ is until today perceived as the spin doctor for energy efficiency in the water sector and performance based contracts. The pioneer work was presented at several regional and international water events such as the World Water Week Stockholm, IFAT München, ACWUA Best Practice conferences, SWIM Regional conference, etc. Due to the promising results and the prominence of GIZ activities in the Jordanian water sector the concept was not only picked up by other development cooperation organizations in Jordan but also in the region. The concept of improving energy efficiency in water pumping was assessed and applied for instance in Yemen, Egypt and Tunisia.

Introducing energetic use of sludge and biogas on wastewater treatment plants

The energy intensity of the sector is improved through the use of alternative sources of energy at waste water treatment plants. Energy can be generated through the collection of biogas during treatment of wastewater or through energetic use of sludge through combustion. Preparatory measures are already implemented. Currently ongoing projects will install respective technology and start produce energy and herewith reduce operational cost for WAJ (2014.2483.7).

The currently ongoing project DISM aims to improve the resource and economic efficiency in the waste water sector. Next to protecting groundwater resources and reducing CO_2 emissions through sustainable sludge management practices economic benefits will be generated through the energetic and productive use of sludge (2014.2483.7).

5.6 Conclusion

Project activities of the German technical cooperation in the field of energy efficiency were pioneering work for Jordan to reduce the sector`s energy intensity. The key impacts of the German support in the field of energy efficiency included:

- providing an objective and reliable energy audit of pumping stations nationwide
- taking the role as mediator and good broker was key in formulating baseline agreements and support in negotiation rounds
- building up mutual trust in the respective public and private business partner as well as in the concept of energy performance contracting
- by introducing economic viable instruments to both, the public and private sector German-Jordanian cooperation also stated that environmental sound technologies can be financially attractive. An important success factor for GTZ/GIZ's work was the presence, role and standing of GIZ project staff to safeguard and enable energy performance contracting in the water sector.

The concept of energy efficiency has been introduced through technical and scaled up by financial cooperation throughout Jordan. Until today approaches are mainly limited to pumping stations and well fields with high electricity consumption. However, the actual saving potential in Jordan`s water sector is much higher: Tapping alternative energy sources, improving inefficient practices and equipment, rehabilitation of water networks and herewith reducing NRW as well as hydrological optimization of distribution networks are potential measures to reduce the sector`s intensity. By using the potential of gravity supply rather than pumping complete pumping stations could be taken off the grid, reduce pressure on others and lower friction losses and/or leakages, which would only require minor changes in the transmission lines (GIZ 2014a). In addition, energy can eventually be generated or recovered from water supply and treatment facilities, which will positively influence the energy intensity of water supplied or treated. Examples are energy recovery at wastewater treatment plants or from transmission lines, pressure breaking tanks or the installation of micro turbines in pressurized networks.

Further, the potential of water infrastructure to buffer and store the production of renewable energy resources (wind, solar) is not yet tapped or assessed. Potentially, the sectors` infrastructure such as storage dams, reservoirs and transmission lines can act as storage power station and eventually generate additional income for water utilities.

5.6.1 Sustainability of GTZ/GIZ-support

The challenge of ensuring the sustainability of measures including the invested capital has continuously to be addressed. Despite capacity development activities accompanying all interventions, weak O&M capacities are a major obstacle for the sustainability of project objectives once the development cooperation support withdrawals. Missing skilled workers and weak capacities in water utilities as well as the private sector are expected to receive a boost through efforts in promoting vocational training in, for example, energy efficient O&M. One major obstacle for keeping performance high of managing equipment energy efficiently is appropriate O&M. However, considering low wages, particularly in the public sector, together with staffing policies (e.g. frequent exchange of personnel) will not support sustainable energy-efficient O&M practices.

Most challenges in Jordan's water sector are interlinked and build on each other.

Jordan`s challenges in the water sector will not be solved by tackling one and neglecting another. Most challenges are interlinked and build on each other. Consequently, improving the sector`s energy efficiency has to go hand in hand with reducing NRW rates, cost recovery of the utilities will have to be accompanied by increasing the water tariff, in particular if subsidies for electricity are released. National strategies and bilateral cooperation agreements are reflecting these prerequisites; it remains however questionable if implementation will proceed as planned due to (geo-) political developments and social tensions.

5.6.2 Outlook

Reducing the energy intensity of the water sector will support the (financial) performance of water utilities and reduce emissions at the same time.

Overall, reducing the energy intensity of the water sector is a necessity, which will support the (financial) performance of water utilities and reduce emissions at the same time. Being financially attractive, the involvement of the private sector through, for example, performance-based contracts will reduce the financial burden on WAJ, provide additional investment capital to the sector and eventually even generate income to the utility. The public companies might play a decisive role in improving the energy efficiency of the water sector. As the Water Sector Capital Investment Plan states "The National Water Strategy 2016 2025 calls for promoting the role of water companies in the field of provision of water and wastewater services, bringing into the sector the rigor and resources of the private sector, both of which are needed for new and more efficient water supply systems" (MWI 2016b)

By demonstrating the feasibility of energetic refurbishment of pumping stations as well as developing and testing contractual models the potential for a sector wide roll-up was created. The development cooperation's objectiveness, and role as a reliable and trustable mediator was key in negotiations and in establishing energy performance contracting as a new field of business opportunities for both, the private and public sector.

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