

THE HASHEMITE KINGDOM OF JORDAN

**Adaptation to Climate Change
In the Zarqa River Basin**

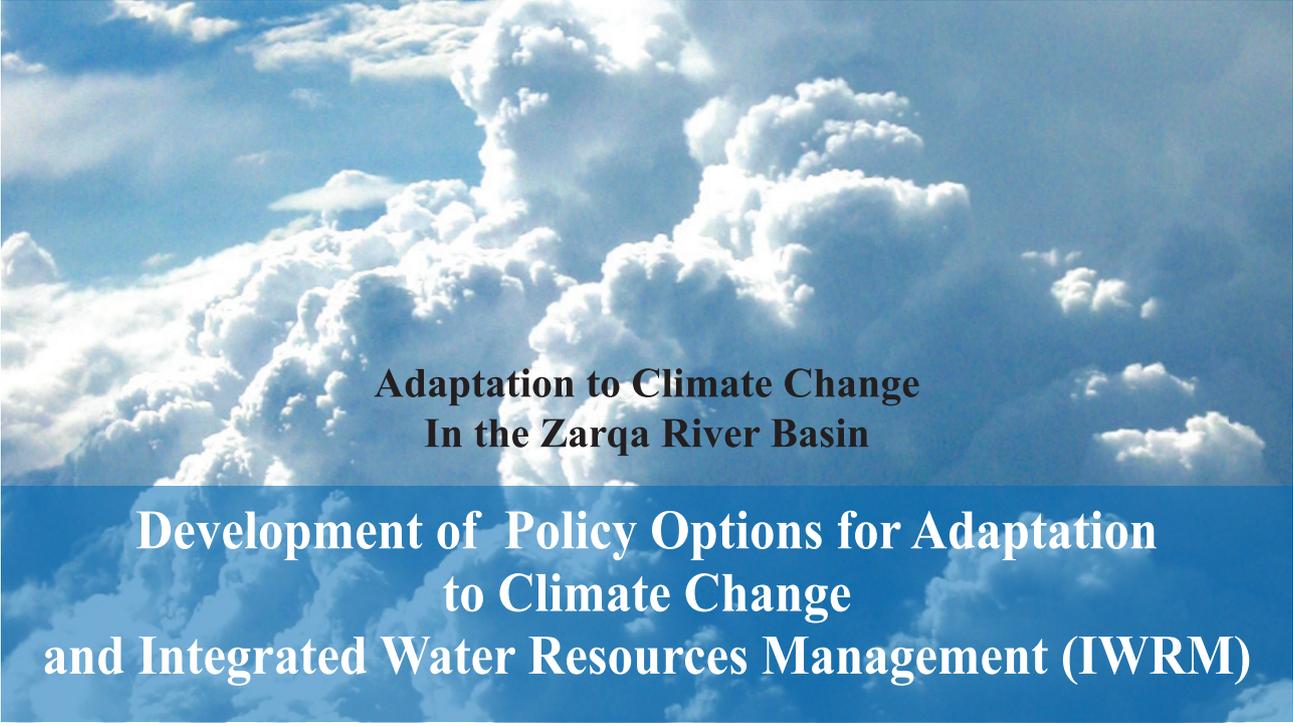
**Development of Policy Options for Adaptation
to Climate Change
and Integrated Water Resources Management (IWRM)**



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Foreword

Jordan is classified as one of the four most water scarce countries in the world. The National Agenda that sets Jordan's development vision till 2015, as well as the United Nations Development Assistance Framework (UNDAF) document (2008-2012), stress that Jordan's remarkable development achievements are under threat due to the crippling water scarcity, which is expected to be aggravated by Climate Change. The UNDAF (2008-2012) addresses four key related challenges to sustain progress towards the MDGs, which include: (i) water scarcity; (ii) drinking water supply security and quality; (iii) health, agriculture and food production vulnerability to Climate Change; and (iv) vulnerability of local biodiversity to Climate Change.

Jordan's Initial National Communication (INC) to the United Nations Framework Convention on Climate Change (UNFCCC) foresees that over the next three decades, Jordan will witness a rise in temperature, drop in rainfall, reduced ground cover, reduced water availability, heat-waves, and more frequent dust storms. The Second National Communication (SNC) to the UNFCCC identifies water as a priority area.

There are several barriers to water sector adaptation to Climate Change that threaten the sustainability of Jordan's achievement of the MDG targets, these include: (i) Climate Change risks not sufficiently taken into account within sectoral policies and investment frameworks; (ii) existing climate information, knowledge and tools are not directly relevant for supporting adaptation decisions and actions; and (iii) weak national capacity to develop sectoral adaptation responses. Jordan's success in adapting to increased water scarcity and related threats to health, food security, productivity, and human security induced by Climate Change is the key to sustaining its human development achievements and growth.

The government of Jordan represented by the Ministry of Planning and International Cooperation (MOPIC), the Ministry of Water and Irrigation (MWI), the Ministry of Health (MOH), the Ministry of Agriculture (MOA), and the Ministry of Environment (MoEnv) have been the implementing partner in carrying out the activities of the United Nations Country Team (UNCT) Joint programme (JP) on "Adaptation to Climate Change to Sustain Jordan's MDG Achievements" which is supported by a team of UN agencies in Jordan consisting of UNDP, UNESCO, WHO-CEHA, and FAO. The JP has worked on the identification of adaptation barriers and gaps have to be addressed, assessment of

the direct and indirect impacts of climate change on the health, nutrition, and livelihood security of people, screening and assessing potential adaptation strategies prior to wide scale application, and assessing and strengthening existing national adaptation capacities.

In addition to the key role of the JP to strengthen and develop the capacity of different institutions and communities in adaptation to Climate Change the JP is to disseminate the wealth of results, information, and studies accumulated during the period of its implementation to stakeholders, scientific and research community, and the public at large.

The component of the JP implemented by the MoEnv in cooperation with UNDP has been focusing on the Zarqa River Basin (ZRB) for its activities. The major activities of this component are: Identifying the direct and indirect impacts of Climate Change on the water sources of the ZRB, identifying barriers and opportunities for Climate Change adaptation in the basin, Developing a Climate Change adaptation programme for the basin, and pilot Climate Change intervention for groundwater protection on one local community in the basin.

This document is the result of a collaborative and joint efforts of many professionals from the government, private sectors, NGO's, and local community representatives to identify the appropriate adaptation measures, come up with tools for prioritization of adaptation to Climate Change interventions, and develop programmes to better adapt to Climate Change impacts for the ZRB towards strengthening the capacity of the basin to adapt with Climate Change impacts. It is hoped that this study will be a motivator for other studies in other basins of the country.

We at the MoEnv hope that this and other studies of the JP will provide a practical guide for the harmonization of the implementation of climate change adaptation and issues within the conceptual system of the strategic planning of all concerned parties.

Eng. Ahmad Al-Qatarneh



**Secretary General
Ministry of Environment**

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This study was part of a multi task project implemented by the MoEnv with support from UNDP. The project represents one component out of four with together form the UNCT joint programme titled “Adaptation to Climate Change to Sustain Jordan’s MDG Achievements” implemented by the MWI, MoEnv, MOA, MOH, and MOPIC, in cooperation with UNDP, WHO-CEHA, UNESCO, and FAO.

This component (MoEnv-UNDP project) was coordinated by a national participatory process that lasted for three and a half years and involved tens of national experts and organizations resulted in the preparation of this and many other studies. The project was funded by the Spanish MDG-F, administered by UNDP, and implemented by the Ministry of Environment.

The project was coordinated by:

- Dr. Munjed Al-Sharif – Joint Programme Co-ordinator and Chief Technical Advisor
- Ms. Rana Saleh - JP assistant

The project management team was supported by the influential efforts of the various counterparts in the Ministry of Environment with special thanks going to Eng. Ahmad Qatarnah, the SG of the MoEnv and head of the MoEnv task force, Eng. Hussein Shahin, Director of Nature Directorate and Eng. Hussein Badareen, Director of Monitoring and Assessment Directorate, the project counterparts at the MoEnv and members of the task force. Appreciation is also extended to the other members of the task force Eng. Abdel Majeed Khaboor, Director of Zarqa Environment Directorate, and Mr. Batir Wardam, Head of the Zarqa river rehabilitation project and unit at the MoEnv.

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The project outcomes and documents were the result of the innovative work of many Jordanian experts joining together a distinguished team representing the Science Triangle for Research, Training, and mangament (STRTM) consulting firm. The technical contribution was provided by:

- Dr. Ali El Naqa, Team Leader (Hashemite University, HU).
- Dr. Mohammad Al Qinneh (HU)
- Dr. Nizar Hammori (HU)
- Dr. Salahuddin Jaber (HU)

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The Ministry of Environment would like to express thanks for all the experts participating in the project reports and action plan development, partners in the Ministry of Water and Irrigation, Ministry of Planning and International Cooperation, UNDP and all organizations that were influential and positive in their support of the project.

ملخص

يهدف هذا التقرير الى مراجعة الأطر القانونية والمؤسسية السائدة في قطاع المياه في الأردن فيما يتعلق بالتكيف مع تغير المناخ في حوض نهر الزرقاء (ZRB). ولتحقيق هذا الغرض فقد تم عمل ما يلي (١) مراجعة الوثائق ذات الصلة في التشريع والإدارة والأنظمة والسياسات المائية وقوانين المياه ، (٢) تحليل وبيان الثغرات في سياسات المياه في الأردن والتعرف على نقاط الضعف الموجودة في هذه السياسات فيما يتعلق بتغير المناخ ، وزيادة الوعي بأهمية وضع تدابير التخفيف من تغير المناخ ، و (٣) العمل على وضع سياسة أو استراتيجية عامة للتكيف مع تغير المناخ من خلال تطبيق الإدارة المتكاملة لموارد المياه كأداة للتكيف مع تغير المناخ.

والهدف من المراجعة هو تقييم مدى ملاءمة وفعالية الإطار المؤسسي القائم بشأن تدابير التكيف مع تغير المناخ في حوض نهر الزرقاء (ZRB) ومكافحة ندرة المياه الذي لا يزال يشكل تحدياً استراتيجياً يواجه الأردن لزيادة موارده المائية. ومن وجهة النظر القانونية هناك ثلاثة قوانين تشكل الإطار القانوني الرئيسي لقطاع المياه في الأردن ، وهي سلطة المياه الاردنية (WAJ) القانون ١٨ لسنة ١٩٨٨ ، وسلطة وادي الأردن (JVA) القانون ٣٠ لعام ٢٠٠١ وزارة المياه والري (MWI) القانون ٥٤ لعام ١٩٩٢. ووضعت هذه القوانين أساساً لتأسيس المؤسسات المعنية وتنظيم أنشطتها. ومع ذلك ، وهذه المؤسسات متداخلة المسؤوليات وأحياناً تعاني من عدم وجود تنسيق وتؤدي إلى حالة من الغموض. لذلك لا بد من وجود قانون المياه يكون أكثر حصافة لحيوية هذا القطاع .

وكذلك يستعرض التقرير الآثار الاجتماعية والاقتصادية لتغير المناخ والتدابير المتخذة بشأن إدارة تغير المناخ والتخفيف من آثاره ويتناول الحاجة إلى خطط لمواجهة الجفاف الإقليمي. ويحتوي هذا التقرير ايضاً على مراجعة الوثائق ذات الصلة بالسياسات المائية في الأردن وكذلك مختلف الاتفاقيات والبروتوكولات الدولية التي وقع عليها الاردن وخاصة اتفاقية تغير المناخ. ومن أجل ذلك فقد تم عقد سلسلة من اللقاءات والاجتماعات مع المعنيين والمهتمين في قضايا المياه والتغير المناخي وكيفية ادراج تغير المناخ ضمن السياسات المائية الحالية ، وتطوير هذه السياسات من خلال دعم الجهود التي تبذلها الحكومة الأردنية من خلال وزارة البيئة لإدماج تغير المناخ في إدارة المياه. كما يهدف التقرير الى تعزيز النقاش حول الفرص المتاحة لمزيد من العمل والبحث عن استراتيجيات لزيادة الوعي والمعلومات ذات الصلة مع تدابير التكيف مع تغير المناخ في قطاعات التنمية في حوض نهر الزرقاء (ZRB). وتحديد الثغرات وتقديم توصيات بشأن سبل ووسائل لمعالجة الثغرات الموجودة لأدراج اساليب التكيف مع تغير المناخ في السياسات المائية الحالية للوصول الى استراتيجية أو خطة عمل.

لقد قامت وزارة المياه والي في الأردن بتبني نهج الإدارة المتكاملة للموارد المائية في وضع استراتيجيات وسياسات المياه. وهذا النهج يعتبر أداة مفيد للتكيف مع التغيرات المناخية وهذا واضح من صياغة استراتيجيات وطنية للمياه وتنفيذ خطط العمل وإصدار لوائح عديدة في دعم السياسات المتكاملة للموارد المائية. ومع ذلك ، تظل هناك فجوة كبيرة فيما يتعلق بقدرة الأطر المؤسسية الحالية لتنفيذ فعال للإدارة المتكاملة للموارد المائية. هذا هو في الأساس لأن إدارة الموارد المائية والثقافة المرتبطة به والترتيبات المؤسسية والتشريعات التي تتخذ نهجاً قطاعياً لا تكفي لتحقيق إدارة موارد المياه بشكل تكاملي. لذلك فان نظم إدارة موارد المياه تتطلب نهج متكامل لتخطيط السياسة الاجتماعية والاقتصادية والبيئية ، والحفاظ على الموارد الطبيعية ، فضلاً عن الطرائق المناسبة لمشاركة الجمهور.

هذا ويقترح التقرير سياسة مائية في حوض نهر الزرقاء (ZRB) لاستدامة موارد المياه في سياق التكيف مع تغير المناخ في الأردن. ويقال أن هذا النوع من السياسات المقترحة لتغير المناخ يمكن أن تساعد في الحد من آثار تغير المناخ مثل زيادة درجة الحرارة وانخفاض هطول الأمطار. ومن المتوقع تحقيق ذلك من خلال تطبيق الإدارة المتكاملة لموارد المياه كأداة فعّالة لمكافحة التغيرات المناخية والتي ترتبط بانخفاض هطول الأمطار وتغيراتها المكانية والزمانية المتوقعة .

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Preface

According to Model Contract for Professional Consulting Services between UNDP and Science Triangle for Research, Training and Management No. (8/2010), This report summaries the results of the second objective of the project “Review opportunities and barriers to adaptation to climate change risks” that include three major tasks (1) Review national water strategy, policies, and action plan as well as other related policies, (2) Identify gaps in these policies as related to climate change vulnerability and adaptation, and (3) Propose policy options for adaptation to climate change to be adopted by policy maker.

1. Scope of the Report

The intention of this report is directed at drawing a picture of the prevailing legal and institutional framework of the water sector in Jordan in relation to climate change adaptation in the Zarqa River Basin (ZRB). To achieve this purpose, three tasks were conducted; (1) literature of pertinent documents on legislation, administration, regulations, water policies and water laws were reviewed, (2) address the gaps in the water polices in Jordan as related to climate change vulnerability, and to raise awareness of the importance of developing climate change mitigation measures, and (3) propose policy options for adaptation to climate change through implementation of IWRM as a tool. The objective of the revision is the assessing the appropriateness and effectiveness of the existing institutional framework regarding the climate change adaptation measures in ZRB. Combating water scarcity remains a strategic challenge that Jordan faces for augmenting its water resources.

From the legal point views three laws constitute the main legal framework of the water sector in Jordan; the Water Authority of Jordan (WAJ) law 18 of 1988, the Jordan Valley Authority (JVA) law 30 of 2001 and the Ministry of Water and Irrigation (MWI) law 54 of 1992. These laws were essentially drawn up to establish the respective institutes and regulate their activities. Nonetheless, responsibilities can be overlapping which can lead to a state of ambiguity. The presence of a water law for the sector should prove more prudent for the sector vitality than these three laws.

In order to examine the socio-economic impacts of climate change this report presents measures taken on climate change management and mitigation and addresses the need for regional drought preparedness planning. The study entailed a review of the existing literature relevant to water policies in Jordan and the status of various conventions/protocols to which Jordan is a signatory. It involved interviewing some of the key professionals dealing with water and climate change issues.

It identifies the gaps and makes recommendations on ways and means to address the gaps in the existing documents. Gap analysis techniques include commenting on what the present state is and how one could get to a desired state. The analysis also looks at the factors that contribute to the gaps and the underlying root causes.

2. Introduction

The issue of global climate change has begun to play an increasing role in scientific and policy debates over effective water management. In recent years, the evidence that global climate change will have significant effects on water resources in Jordan and particularly in ZRB has continued to accumulate.

In recent years, the scientific consensus has broadened that climate changes will be the inevitable result of increasing concentrations of greenhouse gases. There is also a growing consensus that various anthropogenic climate impacts are already appearing worldwide. Evidence of its impacts on hydrologic system of Jordan has also appeared in various forms. Water agencies around the country must begin to consider the implications of climate change for the reliability and safety of water systems, and professional water organizations have begun urging managers and planners to integrate climate change into long-term planning.

Despite climate change projections of severe reduction in water resources in the Arab Region, there seem to be no indication this issue is considered in the current water governance system. In fact, the countries of the Middle East are still lagging in reforming their institutional frameworks to deal with the chronic water scarcity.

Recognizing the magnitude of threat of water scarcity, the Government of Jordan developed a comprehensive water strategy entitled “Water for Life” for the period 2008 to 2022. The Initial National Communication (INC) to the United Nations Framework Convention to Climate Change (UNFCCC) foresees that over the next three decades, Jordan will witness a rise in temperature, drop in rainfall resulting in reduced water availability.

When you talk about climate change, you are also talking about «water change»- they are inseparable. It is also clear that when you talk about climate neutrality you are also talking about water and its future abundance or scarcity. Therefore, at the adaptation front Jordan is facing a severe

challenge in water scarcity to be magnified by the impacts of Climate Change. In a harsh natural environment with limited surface water and heavy demand on groundwater, lack of adequate financial resources for desalination, Jordan is at the front line in the regional fight for innovative solutions to water scarcity problems. The scarcity of water in Jordan is the single most important constrain to the country growth and development as water is not only considered a factor for food production but a very crucial factor of health, survival and social and economical development.

Climate change studies conducted in Jordan are very limited and only focused on the impacts of climate change on one single surface water and one groundwater resources. Considering the scarcity of natural water resources and their anticipated decrease resulting from climate change, the following adaptation measures can be taken:

The current water status of Jordan in the water strategy 2008-2022 emphasized that Jordan is a fast developing nation with a growing population and increasing drinking water demands. As a nation we feel that we have the intrinsic right for development which in the context of Jordan is linked to the availability of sufficient quantities of safe water for domestic, industrial and service sectors. Jordan's renewable water resources are limited and do not suffice, even under the current situation, to meet our water needs. Climate change scenarios all predict a further decline of our water resources. What changes to water management policies are needed to increase flexibility and adaptive management, and how will Jordan meet those impacts of Climate Change? Specific recommendations are sought on issue areas including, but are not limited to the following: supply demand management, surface water, groundwater, wastewater, and irrigational water. For example in order to protect our groundwater aquifers, we need to explore new water resources which will support Jordan's sustainable development. Also, these new water resources will need to strengthen and increase our self-reliance and avoid dependence on outside sources.

Jordan has prepared a progressive water strategy that, if implemented, will resolve several flaws in Jordan's water governance. However, only a general reference was made to climate change in the document (Jordan 2009). Jordan has a water strategy and policies for water utilities, irrigation and groundwater management since 1997/1998. These policies haven't been reviewed since their issuing in 1997/1998. They stipulate that economic, social and environmental considerations are to determine the extent to which water resources are to be exploited, priorities for project implementation and for additional allocations. Legislation and institutional set-up is to be frequently reviewed

particularly in response to emerging needs. Legislation shall allow stakeholder participation and public-private cooperation. Private sector participation and decentralization in the water sector are being promoted in government reform plans.

During the last decade there have been immense interests in Jordan to follow an IWRM approach in developing water strategies and policies. This is evident by the formulation of national water strategies and implementation action plans and the enactment of numerous regulations in support of IWRM policies. However, a significant gap remains with respect to the ability of present institutional frameworks to effectively implement IWRM. This is fundamentally because the existing water resources management culture and its associated institutional arrangements, legislation and instruments - which take a sector-based approach - are inadequate to achieve integrated and participatory IWRM that is multi-sectoral oriented by its nature. Governance systems for IWRM thus require integrated approaches to social, economic, and environmental policy planning, natural resource preservation, as well as appropriate modalities for public participation.

This report proposes a water policy for Jordan and particularly for ZRB within the context of Climate Change adaptation and aids Jordan in moving toward sustainable water resources management. It is argued that the type of climate change policy proposed could help in reducing the climate change impact of increasing temperature and decreasing precipitation. This can be achieved by providing better integrated water management policy as the effect of climate change on water resources is expected to be significant as a result of decrease in precipitation and projected changes in its spatial and temporal distribution.

3. Review of the current status of institutional and legislative settings in Jordan

Jordan has developed water policies and strategies to enhance development, management, and use of scarce water resources. These policies included various measures related to creating enabling environment, defining institutional roles and establishing management tools which are the three main pillars required for the successful implementation of IWRM. For example, Jordan has followed a participatory approach in developing its national water plans with active involvement of governmental agencies, ministries, civil society, water user organizations and others through meetings, workshops, and national conferences. Moreover Jordan has achieved progress in developing investment and implementation plans of the National Water Resources Plans, including the total investment required by the government and those can be made through loans and grants from donors and other financial

institutions. Economic instruments such as cost recovery, taxes, incentives and fines measures were investigated and initiated to make more fund available to improve operation and maintenance costs of water resources infrastructure and, therefore, to increase water use efficiency (UNESCWA, 2005). In the same connection, Jordan has assessed its current and future water resources and demands and the available management tools that could be utilized for IWRM implementation. For instance, with respect to water demand management, a package of measures has been proposed in Jordan to increase water tariff, introduce new modern irrigation techniques, and develop new codes for water use that stress on water savings aspects and assist in enhancing public awareness.

3.1. Legal and Institutional Framework

With the early establishment of Jordan (1921), the legislators realized the importance of water to the socio-economic development of the country. The Department of Lands and Survey was the first institution in charge of regulating and managing irrigation projects, registration of water rights and establishing water settlement court to deal with water rights disputes and water records. Domestic water supplies were the responsibilities of municipalities > local countries.

Water legislation in Jordan dates back to 1936 during the British mandate. It took more detailed shape in the late 1950's to cater for the development of irrigation in the Jordan Valley. The legislation and the institutional arrangements for water administration went hand in hand, so that a law was passed that created an organization to administer some aspects of water.

The first legislation (1936, 1946, and 1952) handled the settlement of land and water rights and entrusted it with the Development of Lands and Surveys. These were followed by legislation (1954) to manage the irrigation through projects implemented by Government and entrusted that responsibility the Water Department of the Ministry of Public Works. The first comprehensive legislation created the East Ghor Canal Authority in 1959 to which the Water Department was attached. The East Ghor Canal Authority (EGCA) was established for the purpose of planning, managing and operating the East Ghor Canal Project. A separate legislation was enacted to care for the supply of municipal water to towns and cities, and created the Central Water Authority (CWA). The Central Water Authority (CWA) was established in 1959 to be responsible for all matters related to water in Jordan excluding those projects under auspicious of EGCA. In 1966, CWA became a division of the Natural Resources Authority (NRA). The two merged in the Natural Resources Authority that was created by a separate legislation in 1965; and Department of Mineral resources of the ministry of National

Economy was attached to it. The Jordan Tributaries Corporation (JTC) was established in 1964 for the purpose of building dams on the Yarmouk river and Side Wadis to the Jordan Valley.

New Legislation created the Jordan Valley Commission in 1973 to care for the planning and implementation of the projects for the social and economic development of the Jordan Valley. Another legislation was enacted in 1974 and created the Domestic water supply Corporation and took away from the Natural Resources Authority the responsibility for supplying bulk water to the population centers. The responsibility of water distribution in the population centers remained with the municipalities and village councils. In 1977 another legislation was enacted for the Jordan Valley Development creating a Jordan Valley Authority that took from the Natural Resources Authority the responsibilities of Operation and maintenance of the East Ghor Canal. Jordan Valley Authority (JVA) was established in 1973 by combining EGCA and JTC into JVA and expanding its responsibilities to include integrated rural development in the Jordan Valley and Southern Ghors.

New legislation was enacted in December of 1983 and created the Water Authority of Jordan which all the responsibilities of exploration, development, conveyance, and distribution of water, with the exception of irrigation projects, was transferred. In 1985, all water divisions in the municipalities including AWSA, the Water Department in NAR, DWC and other wastewater collection and treatment divisions were put in one big institution called « Water Authority ». Water Authority (WAJ) is responsible for all water and sewage systems in Jordan and all the related projects except those in the Jordan Rift Valley which is the responsibility of the JVA.

That was the most drastic measure ever taken. Staffs from the municipalities all over the Kingdom were transferred from the community institution to become government employees. Overnight with some 10,000 personnel along with equipment, stores, vehicles, etc., a monster was created. In 1988 a Ministry of Water and Irrigation was created and brought under its umbrella the Jordan Valley Authority and the Water Authority. The Minister chaired the Boards of both authorities, and the members of the boards were more or less the same. In 1992, legislation was enacted creating a separate cadre for the Ministry operating under the Minister and headed by a separate Secretary General.

It has been noticed that each of the newly created institutions, operating under its respective law, enjoyed a «honeymoon» that varied in its duration. The East Ghor Canal and the Central Water Au-

thority lasted for six years. The Natural resources honeymoon was interrupted by the June war of 1967. The honeymoon of the Jordan Valley Development institutions lasted the longest, between 1973 and 1982, and was pushed into inefficiency thereafter.

The frequent changes in institutional arrangements carried shocks and some chaos. Continuity of responsibilities was not maintained. The longest tenure was for the Jordan Valley Development (1973-present). The responsibilities included the development of infrastructure needed or economic and social development until 1987, but were then reduced and limited to irrigation water resource development.

In addition, there are other actors that are involved in the water sector. The Ministry of Agriculture is responsible for water management at the farm level and extension services. The Ministry of Health is responsible for monitoring water quality and assuring its compliance with water quality standards for public health. The Ministry of Environment is responsible for water resources protection. With the existing setting, it is difficult to differentiate between agencies responsible for planning, policy formulation, regulatory and monitoring aspects and those responsible for water delivery, operation and management of water supply and distribution projects. Therefore, restructuring is needed to separate between the roles of the different institutions, according to the following criteria:

- Agency responsible for planning and policy formulation.
- Agency responsible for water supply projects.
- Agency responsible for operation and management of irrigation projects.
- Agency responsible for operation and management of domestic water and wastewater networks.

Since the establishment of MWI, many attempts have been made to restructure the water sector in Jordan, but all the attempts failed to change the centralized rule of the Ministry. The private sector and stakeholder participation are limited or not available. The importance or research and development are completely ignored by the MWI. So that, fund for research which has been channeled through the government are not given any priority.

Due to the low efficiency in operating and managing of water distribution systems in big cities like Amman, the government will give the private sector a role in managing water supplies. Recently, a contract for managing the city of Amman water distribution system was assigned to a French company.

3.2. Water Administrative Structure in Jordan

Water resources were managed and regulated by WAJ, JVA, Ministry of Agriculture and Ministry of Health until 1988 when the MWI was established. The major objective of establishing the MWI has been to centralize water sector activities in an endeavor to improve its management. This made MWI the official institute in charge of water sector activities that include planning, setting of strategies and policy and research and development.

The Ministry of Water and Irrigation (MWI) is the official body responsible for the overall monitoring of the water sector, water supply and wastewater system. It was created in 1988 and embraces the two most important entities dealing with water in Jordan; The Water Authority of Jordan (WAJ), in charge of water & sewerage systems, and The Jordan Valley Authority (JVA), responsible for the socio-economic development of the Jordan Rift Valley, including water development and distribution of irrigation.

The Water Authority of Jordan (WAJ) was established as an autonomous corporate body, with financial and administrative independence linked with Minister of Water and Irrigation. WAJ is responsible for planning, implementing and operating water and wastewater projects and all water supply and wastewater facilities in Jordan. WAJ explores existing water resources, and maintains and operates water and wastewater networks throughout the Kingdom (WAJ 2009). WAJ's Project Management Unit (PMU) regulates water and wastewater utilities under private management (MWI 2009).

The Jordan Valley Authority (JVA) is charged with the integrated social and economic development of the Jordan Rift Valley from the Yarmouk River in the north to Aqaba in the south, it plays a pivotal role in developing and managing the Valley's water resources. JVA creates partnerships with the private sector where appropriate, and also implement projects stemming from regional agreements on water and development on behalf of the Jordanian government (JVA 2009).

There are three Secretary Generals within MWI, one for MWI itself, one for WAJ and another for JVA. They are required to answer to the Minister. MWI contains eight directorates. Namely, Legal Affairs, Water Resources Development, Deep wells and Drilling, Water Resources Planning, Environment, Public Information Affairs and Awareness, Financial and General Affairs and Project Directorate.

According to the Ministries and Public Institutions and Departments Linked Organization By-Law No.16 of 1988 WAJ and JVA are linked with the Minister of Water and Irrigation. Nonetheless, WAJ is an autonomous corporate body, with financial and administrative independence. It is responsible for public water supply and wastewater services. It is also in charge of the overall water resources planning, construction, monitoring, operations and maintenance. WAJ Secretary General has five assistants; for Technical Support, Planning and Investment, Maintenance and Workshop, Financial Affairs and Administrative Sectors. WAJ has been undergoing reform according to an improvement plan.

Private sector involvement and decentralization in the water sector are being promoted in the Government reform plans. This is in line with overall government policy directed at the promotion of private sector participation in various governmental sectors. A Project Management Unit (PMU) has been established within WAJ since 1996 to regulate water and wastewater utilities under private management. For example, the Greater Amman water supply management contract which has been introduced in 1999. The PMU is mandated to initiate and follow-up privatization contracts. Management contracts and BOT systems have been set up for the construction of water conveyance and water supply projects and wastewater treatment plants.

The establishment of public water companies is another emerging form managing the water sector. Such a company has its own board of directors with representatives from MWI, concerned ministries and authorities. MWI embarked on an ambitious restructuring programme in order to increase efficiency in Water Sector. Decentralization has been at the center of such efforts. This has been epitomized by delegating management responsibilities from WAJ to regional units operating on commercial basis with Private Sector Participation (PSP). An example is the Northern Governorates Water Administration (NGWA) which was founded in 2001. NAGWA is comprised of the 4 Northern governorates of Irbid, Jerash, Ajloun and Mafrq (including North Badia). It started operation in January 2002, and provides water supply and wastewater disposal services to more than 1.4 million people living in a predominantly rural service area.

The PMU of WAJ is managing the transition period with support from an international aid agency. Established in 1977, JVA has been entrusted with the social and economic development of the Jordan Rift Valley, Jordan's major agriculture region. It has also been delegated the responsibility of developing, maintaining and protecting water resources. In addition to the 110 km King Abdullah Canal, JVA is also responsible for all dams and reservoirs in the country. JVA has a Secretary General who has six assistants; for Planning and Environment, Southern Ghors and Wadi Araba, Lands and

Urban Development, Administration, Finance and Tenders, Northern and Middle Ghors, and Studies and Projects.

The water sector is known to increase government debt problems. This is attributed to the annual subsidies paid to WAJ and JVA. About 25% is known to go for interest payments on external loans contracted for investments in hydraulic infrastructure. WAJ consume seventy five percent of this amount. On the other hand, there are the indirect energy subsidies given out to farmers. Only half of the water sector expenditures are recovered through levies and associated charges. It is worth mentioning that the total water quantities billed by WAJ amount to about fifty percent of the water quantity produced. This has been attributed to “technical and financial losses” caused by the unaccounted for quantities of water. While this is for municipal water, water for irrigation in the Jordan Valley is sold by JVA at 11-12 Fils/m³ (JD is 1000 Fils, One JD equals 1.41 USD) which is considered rather low as farmers in the highlands put up with a 50 Fils/m³. The low water tariffs are seen somehow justifiable because JVA main mission is to promote social and economic development in the Jordan Valley. Nonetheless, full cost recovery is targeted for 2020. It is estimated that 30% of the «cost recovery gap» can be achieved through improvements in operational efficiency and a further 30% by the institution of better integrated investment planning.

The government of Jordan has been persistent in decreasing debt. All economic sectors in the country will play its role in this policy. The water sector is no exception. To achieve this, three main areas of action have been identified in the water sector. These are increasing WAJ and JVA efficiency through technical and administrative measures including privatization, increasing water tariffs and intensification of the investment planning process. However, it is believed that about 40% of the financial deficit of the water sector would have to be covered through tariff increases. Further still, the average cost of production and conveyance will be on the increase due to more costly investments and environmental requirements. Nonetheless, it is recognized that tariff reviews should take into account socio-economic implications.

3.3. Regulatory Framework of Water Law

The main legal framework of the water sector in Jordan is synchronized mainly by three laws. The Water Authority of Jordan (WAJ) law 18 of 1988, the Jordan Valley Authority (JVA) law 30 of 2001 and the Ministry of Water and Irrigation (MWI) law 54 of 1992.

Law 18 of 1988 was essentially promulgated to establish and regulate WAJ which was established as an autonomous corporate body, with financial and administrative independence. It is authorized to institute legal proceedings, own movables and real estate, acquire water rights by purchase or acquisition, conclude loans, accept grants or contributions and sign contracts. It is to carry the full responsibility for all water and wastewater systems and the related projects and shall set forth a water policy. In order to achieve its objectives, WAJ was assigned with the following responsibilities and tasks:

1. Survey the different water resources, conserve them, and determine ways, means and priorities for their implementation and use, except use for irrigation.
2. Set up plans and programmes to implement approved water policies related to domestic and municipal waters (commercial, industrial and touristic) and sanitation, and to develop water resources in the country and to exploit them for domestic and municipal purposes, including digging of wells, development of springs, treatment and desalination of waters, and execute works to augment the potential of water resources and to improve and protect its quality.
3. Direct and regulate the construction of public and private wells, investigate water resources, and drill exploratory, reconnaissance and production wells, and license well drilling rigs and drillers.
4. Study, design, construct, operate, maintain, and administer water and public wastewater projects including collecting, purifying, treating, disposing of water and wastewater, and the methods of dealing with water.
5. Draw terms, standards and special requirements in relation to the preservation of water and Water basins, protect them from pollution, and ascertain the safety of water and wastewater structures, public and private distribution and disposal networks, and take the necessary action to ensure technical control and supervision, including, all necessary tests.
6. Carry out theoretical and applied research and studies regarding water and public wastewater to achieve its objectives including the preparation of approved water quality standards for different uses and technical specifications concerning materials and construction.
7. Issue permits to engineers and licensed professionals to perform public water and wastewater

works; and participate in organizing, special training courses to qualify them in order to improve the standard of such works and to reduce water losses and pollution.

8. Regulate the uses of water, prevent its waste, and conserve its consumption.

By this Law, WAJ is to have a Board of Directors, chaired by the Minister of MWI and comprised of the Secretary Generals of JVA, ministries of Planning, Agriculture, Municipal and Rural Affairs, Environment, Health, Industry & Trade, Finance, Energy and Natural Resources and a member with expertise and specialization appointed for two years. The Board undertakes the following duties and responsibilities:

1. Set a water policy that reserves the rights of the country in all its water resources including the development, maintenance and use of the resources.
2. Approve the water policy of the country and the plans for the development and conservation of water resources, specify water distribution and uses, provide additional water resources and approve plans regarding, the construction of water and public wastewater networks.
3. Study WAJ's draft Regulations and submit them to the Council of Ministers for approval.
4. Study WAJ's proposed annual budget.
5. Obtain foreign and local loans with the approval of the Council of Ministers.
6. Recommend to the Council of Ministers tariffs for connections, subscriptions, price rates and deposit fees that should be collected for various water and public wastewater uses.
7. Invest WAJ funds and revenues with the approval of the Council of Ministers.
8. Appoint members of Water Councils in the districts.

WAJ Secretary General (SG) is the executive manager, responsible to the Minister. He is responsible for the implementation of its policy and plans and administers its financial and employee affairs.

WAJ capital consists of government contributions, donations and subsidies. Its financial revenue is made of water prices, subscriptions, deposits fees collected in return for its various services, loans, donations and subsidies. WAJ funds are considered State Funds and to be collected according to the State Funds Collection Law in effect. Thus WAJ SG is entitled to exercise the powers of the Administrative Governor and of the Collection of State Funds Committee provided for in this Law. WAJ has the right to issue Debt Bonds or Loan Certificates or any other bonds according to the laws in effect. All existing buildings in the country, on the coming into effects of this law, and those erected there-

after, except buildings of worship, are subject to an annual contribution of 3% three percent on the net rent as evaluated in accordance with the tax on buildings and lands Law within the municipality borders. This contribution is levied together with buildings and lands tax by the Ministry of Finance and transferred to WAJ.

The Law requires WAJ to allocate an amount not less than 10 percent of its net profit per annum as a Compulsory reserve. This shouldn't, however, exceed 20 percent of its Capital at the end of the fiscal year. It is further required to allocate the balance of the net profit to finance its projects.

By this Law, all responsibilities related to water and wastewater which were previously delegated to other governmental department, are to be transferred to WAJ. This Law has also given WAJ the authority to:

- Establish the required departments in all parts of the country in order to fulfill its obligations.
- Purchase, acquire or lease properties, land and the related easement rights and the water rights required for the various WAJ and provide a prohibited area as deemed necessary for its water and wastewater networks and the related buildings and construction.
- Manufacture and produce commodities needed for its water and wastewater works, and provide all the equipment necessary for water and public wastewater projects.
- Take the necessary action to ensure technical control and supervision regarding the construction, operation and maintenance of all water projects and public or private sewers.
- Obtain data and information regarding the needs of the country and the actual consumption of water for different uses, and utilize such data for future planning, to provide for the Country's needs for water and to conserve its consumption.

This law stipulates that all water resources available within the boundaries of the country, whether they are surface or ground waters, regional waters, rivers or internal seas are considered State owned property and shall not be used or transferred except in compliance with this Law. Any water resources that are not under the management, responsibility or supervision of WAJ, shall not be used in excess of personal or domestic needs or other acceptable private usage; nor in excess of legal water rights in accordance with the laws and regulations in effect including drinking, and irrigation rights applicable to the area of land which contains that resource. All natural and juridical bodies are prohibited to sell water from any source or grant or transport it, without obtaining in advance the written approval from WAJ and within the conditions and restrictions decided or included in the contracts or agreements concluded between them and WAJ. All persons on whom the provi-

sions of paragraphs (b) and (c) of this Article are applicable, shall adjust their conditions to suit these provisions within a period of three months of the date this Law becomes effective. Otherwise, such persons will be subject to the legal and other punishments stated in this law.

The Council of Ministers, upon the recommendation of the Minister, may assign any of WAJ` duties or projects or the execution of any stage or part to any other body from the public or private sector, or to a public shareholders company, or to a limited-liability company owned totally by WAJ or in which WAJ contributed to the capital. Such assignment may include the transfer of the management of these projects or the lease, or the transfer of ownership to any of these bodies, in accordance with the conditions and for the durations to be set in the contracts that shall be concluded for this purpose, provided that they abide with the legal provisions in force relating to leases and transfer of ownership. In the case of conclusion of contracts to transfer the management of the projects or the lease thereof, the decisions of the Council of Ministers may include the authorization to the officials of the bodies contracted therewith, to exercise the same powers bestowed on WAJ officials in pursuance of legislations in force relevant to the execution of these contracts.

Law 18 also specified penalties of no less than a six months sentence, and no more than two years imprisonment or to a fine no less than JD 1000 and no more than JD 5000, or both punishments if any, inter alia, of the following acts is committed:

- Polluted any water resource, which is under the management or supervision of WAJ directly or indirectly, or caused its pollution and failed to remove the causes within the period fixed by WAJ.
- Drilled unlicensed ground water wells or violated the conditions of the license issued to him.

Also a phrase of no less than one month, and no more than six months, imprisonment or a fine not less than JD 100 and not more than JD 1000, if any, inter alia, of the following acts is committed:

- The illegal usage of water, water resources, related projects or the public sewers, contravening the provisions of this Law, or other pertinent issued regulations, including the selling, granting or transporting water, using or utilizing it or committing any act that may cause harm or damage to any of these resources or water related projects, or using the public sewers in a manner that conflicts with the provisions of this Law.
- Carrying out any works regarding water or wastewater without obtaining the licenses, permits or approvals required under this Law. Or carrying out any of these works in violation of the regulations issued.

Law 30 of 2001 is an amended law of Jordan Valley Development Law of 1988 according to which the Jordan Valley Authority (JVA) has been established to conduct, inter alia, social and economic development of the Valley. The boundary of the Valley is defined as the area between the Northern Frontier of Jordan to the North and the Northern edge of the Dead Sea to the South and the Jordan River to the West until elevation 300 meter above the sea level to the East. It also includes the area between the Northern edge of the Dead Sea to the North, and to the Southern Boundary of Qatar village to the South, and to the Western frontier of Jordan to the West, and to elevation 500 meter above sea level to the East. Through this Law, JVA is mandated to develop and protect water resources of the Valley for purposes of irrigated agriculture, domestic and municipal uses, industry, generating hydroelectric power and other uses. This is to be done through conducting studies, planning, design, construction, operation and maintenance of irrigation projects, land reclamation, overseeing of public and private wells.

JVA may be considered an autonomous corporate body. It is also entrusted with Development of tourism in JV. With the exception of irrigation projects and water resources development projects, JVA can adopt commercial basis in managing its projects but according to instructions issued by the Cabinet of Ministers. Similarly, JVA is entitled to entrust its projects to any entity from the private sector whether by leasing, management or operation, in accordance with the effective laws and regulations.

JVA is comprised of the Minister of MWI, Board of directors, Secretary General and Executive and Administrative Units. Composition and role of the Board are somehow similar to those of WAJ. Notably however, is the inclusion of members from the Ministry of Tourism and Farmers Association. This is driven by the nature of the region under JVA jurisdiction. The role, duties and responsibilities of JVA Secretary General is analogous to those of WAJ SG.

The waters acquired by means of projects constructed by the JVA and which were not used or exploited for irrigation purposes in any area prior to the declaration of a water settlement in accordance with the land and water settlement law in effect, shall be considered Government property. Such waters may be sold, leased, or otherwise disposed of in a way as may be decided by the Board. JVA determines allocation and usage of surface and ground water, developed under its supervision, in accordance with guidelines issued by the Cabinet of Ministers upon Board recommendations.

Before constructing any irrigation projects, JVA has to consider the rights to water in the Water Register. Excess water is considered Government property. JVA divides irrigable lands into farm units and exercises its authority on them in many ways as set by the Board. One of which are the set of regulations for controlling the use of water in farm units. Control includes basis for water supply or barring it. Determining the maximum quantities to deliver in accordance with water availability and the nature of the crops planted in the unit. Water prices, however, are determined by the Cabinet of Ministers upon recommendations from the Board.

JVA implements water quality testing programs in an effort to identify pollution causes. It is mandated to punish polluters, by cutting off water supply to farming units in which pollution was found. Water supply is only resumed when pollution is removed by the owner of the farming unit.

MWI By Law 54, 1992 is the Regulation for the Administrative Organization of the Ministry of Water & Irrigation. Attached to the Minister are MWI, WAJ and JVA. Under this regulation and with due observance to the provisions of the aforementioned WAJ and JVA laws, MWI is entitled to assume full responsibility for water and public sewage in the country. It is to develop and communicate water policy to the Council of Ministers for adoption. Also, MWI shall assume full responsibility for the economic and social development of the Jordan Valley as well as carry out all the works which are necessary for achieving this objective. MWI is to have directorates of Planning, Development & Information, Financing & Loans, Legal Affairs, Citizens Service and Financial & Administrative Affairs. The Regulation allows for the creation, cancellation or merger of directorates and / or units. MWI has a SG responsible for, inter alia, policy implementation. By this Regulation, the Directorate of Planning, Development & Information (DPDI) is required to participate in setting a strategy for the water sector, preparation of programs, conducting and evaluation studies pertaining to economic, social and population feasibility pertaining to water policy. Formulate work plans proposals on the productivity of MWI manpower. Participate in conducting studies on water resources, evaluation and determination of the productive capacity; formulate the basis for its preservation and protection from pollution. Conduct studies, compile and organize the information water quality, industrial waste, follow up of changes in the water specifications and propose the necessary solutions for their treatment. By this regulation, DPDI is also expected to establish a computerized Information Bank in order to analyze and classify the information on the water sector and its development.

MWI directorates are to conduct their undertakings in cooperation and coordination with WAJ and

JVA in accordance instructions issued by the Minister. A Consultative Body comprising SGs of MWI, WAJ, JVA and four qualified members appointed by the Council of Ministers is to be formed. This Body is to provide technical, economic, legal, financing, and administrative advice on the policies, programs and plans put forward by MWI. It is also to evaluate present and future water projects, strategies and policies.

While the aforementioned laws; of WAJ, JVA and MWI constitute the main legal framework of the water sector in Jordan, there are the health and environmental laws which contain clauses addressing respective aspects of the sector. Temporary Public Health Law No. 54 of 2002 insinuates that the Ministry of Health (MOH) shall in coordination with the relevant authorities; control the potable water, regardless of its source, in order to ensure its fitness from health point of view. MOH is entitled to control potable water resources and their networks, in order to ensure that they were not exposed to pollution. It is also to have control over the method to be used in the treatment, transmission, distribution, and storage of potable water, in order to ensure the availability of health conditions in such processes, including the quality of materials used in the potable water processes, its transmission, distribution, and packing, as well as the prevention of using any material that may harm the consumer's health. Any person who is responsible for a water resource, network, station, or potable water bottling factory must inform MOH or WAJ, or both of them, as the case may be, of the occurrence of any pollution to the water placed under his supervision.

Environment Protection Law for the year 2003 caters for the protection of environment and promotion of all its elements including water. The Ministry of Environment (MoEnv) is delegated the responsibility of protecting the environment and promote all its elements such as water, air and land in a sustainable manner and to monitor these elements and their components. Article (23) (A) demands that Cabinet Council shall issue a host of Regulations for the implementation of the provisions of this law including those for the protection of nature, water, sea shore and a regulation for environmental impact assessment. Article (8) specifically prohibits and subjects to the legal responsibility, to cast away any polluting or harmful substance to the sea environment in the regional waters of the country or on the shore area.

Currently there are six major laws governing the management and use of water in the country:

1. The Water Authority Law (no. 18 for 1988)

This law created the Water Authority in Jordan in 1988, and is still the most comprehensive legisla-

tion dealing with water issues. It sets the responsibilities of the WAJ as full control of the monitoring and management of water resources. The law gives WAJ the authority to direct, regulate and license the construction of private wells. The law considers all water resources in the country to be state-owned property. Any person who attempts to use water resources without a license from the WAJ can be fined, according to the law.

2. The Jordan Valley Authority Law (no. 30 for 2001)

This law controls the use of water resources in the Jordan Valley, the main centre of agricultural activities in the country. It also sets guidelines on land ownership and farming activities in the Jordan Valley. It has full authority over water resources, and the right to settle any disputes in water allocation. The law gives JVA the mandate to manage any project in the region in a commercial way, with the exception of water resources development and irrigation projects.

3. The Ministry of Water and Irrigation bylaw (no 54 for 1992)

This bylaw created the MWI in 1992. It provides the Ministry with full responsibility for water and public sewage in the Kingdom. The bylaw established a special directorate in the Ministry called the Citizen Service Directorate which assumes the functions of conducting studies, designing enlightened strategies of education and information provision, which aim at the minimization of water consumption in houses, factories and agriculture.

4. The groundwater bylaw (no. 85 of 2002)

This important bylaw was established in 2002 to meet the urgent need for conserving the country's scarce and depleting groundwater resources. In this bylaw the ownership of the groundwater wells was maintained to lie with the state. Even land ownership does not mean ownership of groundwater resources. The WAJ will issue a license to use water within limits of extraction rates. According to the bylaw the MWI determines the maximum quantity of underground water permitted to be extracted annually from each ground water basin, within the limits of safe yield. The strict clauses of the bylaw clearly reflect the severity of the groundwater situation in the country, and the uncompromised authority of the state in controlling this resource and preventing its over-exploitation. However, the number of illegal wells is still rising, to more than 400.

5. Environmental protection law (no 1 of 2003)

This law established the Ministry of Environment, which evolved from the previous General Corpo-

ration for Environmental Protection (GCEP). The new Ministry was given coordinating, rather than administrative and management authority, over water resources.

6. Drinking Water Standards

The drinking water standard in Jordan (No. 286:2001) is based on the WHO drinking water standards. The standards were raised in 2001, after a major drinking water pollution outbreak occurred in Amman in the summer of 1998 due to a malfunction of the capital's major drinking water treatment plant. The standard includes specific measures to be undertaken in case of the occurrence of pollution in drinking water samples, and the frequency of testing samples that is directly correlated to the number of people served by the water supply.

3.4. The National Water Strategy

In accordance with Article 5 of the Water Authority Law No.18 of 1988 and pursuant to the Council of Ministers approval, the basic strategy and policies for the water sector of Jordan have been formulated and published by the Ministry of Water and Irrigation (MWI 2009).

Jordan has formulated the water strategy in 1997 (currently is being reviewed and updated). In 2009, a new strategy (Water for Life) was issued based on vision-driven change effort. This Water Strategy for Jordan identifies plans for future water and the actions that will be taken to ensure that water is available for people, business and nature. It sets the vision of what we want to have by 2022. It looks at all aspects of the water cycle from rainfall to collection, treatment and discharge. The practical steps needed to take include an effective Water Demand Management, an efficient Water Supply Operations and a well developed institutional reform.

The strategy stresses on the need for improved resources management with particular emphasis on sustainability of present and future uses, water protection against pollution, depletion of water resources, achieving the highest practical efficiency in the conveyance, distribution, application and use of water resources. The strategy takes into account both supply and demand management. The strategy ensures that the rightful shares of the Kingdom's shared water resources will be achieved through bilateral and multilateral negotiations and agreements. Jordan's water strategy provided the foundation and initiative to develop policies addressing specific issues facing Jordan's water sector. Four policies have been developed and approved by the Cabinet of Ministers (Ministry of Water and Irrigation, 2002). The institutional and legal reforms are addressed below as relevant to each

developed policy.

The Strategy stresses that the full potential of surface water and groundwater shall be tapped to the extent permissible by economic feasibility, and by social and environmental impacts and that the use of ground and surface water with different qualities shall be considered. The strategy also considers that wastewater should not be managed as waste; wastewater is to be collected and treated for reuse in unrestricted agriculture and other non-domestic purposes, including groundwater recharge. Similarly, also brackish water and desalinated sea water shall support irrigated agriculture and to produce additional water for municipal, industrial and commercial uses. “Priority criterion for project implementation, and for additional water allocation, shall be based on economic, social and environmental considerations. A «critical path» shall be established for the allocation of each new source of water. Consideration shall be given to the sustainability of the allocation in the light of the national water balance situation and the economic, social and environmental opportunity cost of forgone alternative uses of water. First priority will be given to allocation of the basic human needs; as such, first priority is given to allocation of a modest share of 100 liters per capita per day to domestic water supplies. Expensive additional water has municipal purposes as a first priority in allocation, followed by tourism and industrial purposes” (MWI 2009).

3.5. Water Policies in Jordan

There are many water management challenges in Jordan due to severe water shortage, the rapid population growth and increase in industrial development. The gap between water demand and supply is increasing and is compensated by over exploitation of available groundwater resources. Water scarcity is expected to increase in the future and may result in a decrease of water use for agricultural purposes.

The MWI has issued its water strategy and policy in 1997 & 1998. They were published in 2002 (MWI, 2002). This had been to satisfy the relevant legislative requirements of Article 5 of WAJ Law 18 of 1988. The relevant issued documents are:

- Jordan’s Water Strategy (MWI, 1997a),
- Water Utility Policy (MWI, 1997b),
- Irrigation Water Policy (MWI, 1998a),
- Groundwater Management Policy (MWI, 1998b),
- Wastewater Management Policy (MWI, 1998c).

The updated water for life strategy (2008 – 2022) mentioned above has went through another cycle of revision and the updated outcome has a significant focus on the impact of Climate change on water resources and how to tackle these impacts at the different levels of planning and management of the water sector.

The strategy and policies were formulated with an obvious target of promoting sustainable utilization of the already scarce natural water resources. Improvement in the quality of life for the Jordanian citizen has been the ultimate development goal and thus dictated the prevailing approach of implementation.

As would be expected, the strategy duly recognizes pressures imposed by population increases, due to natural growth as well as to sudden waves of immigration that Jordan had encountered. The fact that populations are concentrated in distant locations from water resources resulted in higher costs for water supply projects and associated services. Prominent among which is the high annual cost of operation and maintenance of which energy is responsible for 55%. Increasing water demand has necessitated over abstraction from groundwater aquifers. Relaxed controls on drilling wells and lack of controls on abstraction rates resulted in some ground water aquifers being depleted and others being salinized.

By international standards, the marginal cost of water is considered high and is on the rise. Water networks have been in need of rehabilitation and yet present another formidable technical and financial challenge. Additional water resources that can be mobilized are modest.

In view of the aforementioned status and anticipated trends in the water sector, the Water Strategy was adopted by the Government of Jordan. Policy documents mentioned above were issued with an aim of detailing Government's policy and intentions pertaining to water sector and respective sub-sectors. Including Resource Development, Resource Management, Legislation and Institutional Set-Up, Shared Water Resources, Public Awareness, Performance, Health Standards, Private Sector Participation, Financing and Research & Development. Highlights of the most relevant aspects of the water policies can be described briefly in this report as follows:

- a. On Resource Development:** Water is and shall be always considered as a national resource. Economic feasibility, social and environmental impacts are to determine the extent to which surface and ground waters may be exploited. A periodic assessment of potential water resources

and their respective uses should be conducted, including marginal and brackish waters. An overall far-reaching water resources development plan is to be formulated, from which a revolving and dynamic five year plan shall be drawn in line with other economic sectors. Concurrently, an investment plan is to be drawn. Economic, social and environmental considerations should dictate the priorities of project implementation and for additional water allocation. Allocation of new water sources should be determined through a critical path approach. This has to be considered within the context of the sustainability pertaining to national water balance, the socio-economic and environmental factors. At any rate, foremost priority should be given to satisfying basic human needs. One hundred liters per capita per day is the priority amount allocated to domestic water supplies. Priority is then for municipal purposes, followed by tourism and industrial purposes.

- b. On Resource Management:** Sustainability of use of already developed sources is given priority. Exploitation of renewable groundwater aquifers should be reviewed, brought under control and extraction rates made sustainable. A dynamic demand and supply management approach is to be pursued making use of instruments of advanced technology. Persistent efforts shall be exerted to improve efficiency of conveyance, distribution, application and use. Water requirements for future industrial, commercial, tourism and agricultural projects should be included into the cost of production.
- c. On Legislation and Institutional Set-Up:** Existing institutional provisions and legislature are to be subjected to frequent review and subsequent adjustments as deemed appropriate. In particular, to respond to emerging needs. Legislation shall allow for stakeholder participation and ensure public – private cooperation.
- d. On Financing:** Cost recovery of utilities and service provision shall be sought out. The standard practice shall be the cost recovery of operation and maintenance. However, capital cost recovery shall be approached with care. Cost recovery shall be set while accounting for the cost of living and per capita share of Gross Domestic Product. Also, in setting water tariffs, the need for and requirements of private investment shall be taken into consideration. On the other hand, non-domestic users shall pay a fair cost. Project financing will depend on loans, private borrowing and/ or BOO and BOT arrangements. This is to remain so till the cost recovery is full, and the domestic savings become capable of local financing of development projects.

- e. On Research and Development: Efforts shall be exerted to promote indigenous water research in the various fields; e.g. resource management, resource economics. Forging partnerships with international research institution shall be encouraged in order to keep current with technological advances and to facilitate technology transfer and adaptation.
- f. On Public Awareness: It is recognized that water administration alone is insufficient to confront the water problem. Educating the public about the need for water to be used in a sustainable manner and underlining its importance for economic and social development is equally important.
- g. On Health Standards: National water standards shall be set and enforced. Water quality testing laboratories shall be maintained and properly equipped.
- h. On Private Sector Participation: Role of the private sector shall be expanded. Management contracts, concessions and other forms of private sector participation in water utilities shall be considered and adopted as appropriate. BOT and BOO concepts shall be considered. However, these are to be subjected to continuous assessment to identify and mitigate negative implications. The Government of Jordan has been carrying out economical restructuring enabling the private sector to assume a more important role. In this, water and wastewater services management are considered of priority in regard to private sector participation (MoP, 2002).

3.5.1. Groundwater Management Policy

The groundwater policy is highly justified, frequent reference to the over-exploitation of groundwater resources, and it emphasizes on the sustainable use of aquifers and the state ownership of groundwater resources. The policy sets specific objectives and principles for groundwater use and management. Particular emphasis has been placed on the potential of brackish water desalination for drinking purposes.

On resource development, the policy states that development of groundwater reservoirs shall be commenced only after careful studies are made of the potential of each, and observation wells installed in carefully chosen locations to monitor the reservoir during exploitation.

The policy makes clear that the priority of allocation of groundwater shall be given to municipal and industrial uses, to educational institutes and to tourism. These purposes are deemed to have the highest returns in economic and social terms.

The policy states also that expropriation of use rights arising from legal use of groundwater, or of water rights established on springs rising from groundwater reservoirs shall not be made without clear higher priority need, and fair compensation. Moreover, priority shall be given to the use in irrigated agriculture of those reservoirs whose water quality does not qualify them for use in municipal and industrial purposes.

3.5.2. Irrigation Water Policy

Irrigation water policy includes agricultural use, resource management, technology transfer, water quality, and efficiency. Specific policy statements includes: sustainability of irrigated agriculture, resources development and use, technology transfer, farm water management, irrigation water quality, management administration, water pricing, regulation, and control. The policy adapted the management of irrigation water as an economic good and the price of water should cover at least operation and maintenance costs and if possible the capital costs as well. The water price varies according to its quality in the developed policy. The implementation of irrigation water policy is the responsibility of JVA.

The irrigation water policy focuses strongly on the lack of balance between population growth and water resource availability. It tackles the contentious issue of agricultural allocation of water resources from various perspectives to reach a sustainable balance of allocation system.

The policy clearly states that irrigated agriculture provides most of the agricultural production in the Kingdom and offers the highest percentage of agricultural jobs and other jobs in support services. It also strongly emphasizes the role of wastewater since it states that because of the huge imbalance in the population - water resources equation, the treated wastewater effluent should be added to the water stock for use in irrigated agriculture. It will constitute a substantial percentage of the irrigation water in future years.

On the sustainability of the irrigated agriculture sector the policy states that:

1. Existing areas of irrigated agriculture shall be allocations according to the chances for sustainability. No diversion of its waters to other uses shall be allowed without providing a replacement source fit for agricultural use unrestricted by health and public health considerations.
2. Sustainability of agriculture shall be compromised only if it threatens the sustainability of use

of ground water resources. Potential pollution of underlying aquifers or the depletion thereof is among the reasons that can prompt such a compromise.

3. Surplus surface water during the wet season shall be provided to farmers through the irrigation networks, free of charge, to leach soils, especially to those farms that are irrigated with treated wastewater in the dry season.
4. In remote sparsely populated areas, and after satisfying the local municipal and industrial needs from unallocated water resources, water resources shall be allocated to agricultural production including livestock.

The policy sets specific principles for the on-farm use of irrigation water. These principles include that crop water requirements in the various micro-climatic zones of the country shall be experimentally determined, taking into consideration the prevailing different water qualities.

There is a direct emphasis on the quality of agricultural water and health criteria. The policy states that when treated wastewater is a source of irrigation water, care should be taken, to the maximum extent possible, to have the quality improved to standards that allow its use for unrestricted irrigation. This can be achieved through blending with fresher water sources. The same applies to the potential use of drainage water or brackish water sources. However, farmers should be apprised of the potential quality of irrigation water so that their choice of crops is made with the necessary background information and knowledge.

The policy includes “new” principles for the pricing of irrigation water. It states that irrigation water shall be managed as an economic commodity that has an immense social value. Like other water resources, irrigation water is a national commodity owned by society at large without prejudice to existing water rights. The water price shall at least cover the cost of operation and maintenance, and, subject to some other economic constraints, it should also recover part of the capital cost of the irrigation water project. The ultimate objective shall be full cost recovery subject to economic, social and political constraints. Due consideration shall be made of any water rights as established by law. Moreover, differential prices can be applied to irrigation water to account for its quality.

3.5.3. Utility Water Policy

The utility water policy addresses ten issues: institutional development, private sector participation, water pricing and cost recovery, human resources, water resources management, water quality and

environment, services levels, public awareness, conservation and investment. Jordan has a pioneer experience in private sector partnership. The WAJ has a management contract with International Consortium for Management Contract of Amman (LEMA) to construct, operate and manage water infrastructure and water services and sanitation. This experience had many positive impacts: it reduced the unaccounted-for-water (UFW), increases water allocated to Amman by 10%, improves capacity building of the staff, and reduces the water treatment cost by 10%.

3.5.4. Wastewater Management Policy

The wastewater management policy includes resources development, resources management, wastewater collection, and treatment, reuse of treated effluent and sludge, and pricing. The total investment required is 1266 MDJ (1 Jordanian Dinar = 1.4 US\$) of which 19% is covered by the government, while 56% is covered by international donors.

The wastewater policy states that wastewater shall not be managed as «waste». It shall be collected and treated to standards that allow its unrestricted reuse in agriculture and other non-domestic purposes, including groundwater recharge. In a clear link to the basic rights of water for domestic use, the strategy's first priority was the allocation of the basic human needs. Expensive additional water has municipal purposes as a first priority in allocation, followed by tourism and industrial purposes. In order to develop a Wastewater Management Policy, the following represent the key issues under consideration:

1. Provision of adequate wastewater collection and treatment facilities for all the major cities and towns in Jordan.
2. Protection of the environment and public health in the areas affected by the proposed systems, especially, surface waters and ground waters.
3. Consideration of treated effluents as a source for irrigation reuse.
4. Improvement of the socioeconomic conditions in the areas to be served by the proposed systems.

3.5.5. Water demand Management Policy

In order to address some of Jordan's water problems, a National Water Strategy was developed and approved in 1997. Water demand management is currently a part of the Water Strategy for Jordan (Hashemite Kingdom of Jordan, 1997), which states that "resource management shall continually aim at achieving the highest possible efficiency in the conveyance, distribution, application and use"

of water resources.

The MWI has established a Water Demand Management Unit (WDMU) to provide knowledge and increase awareness on reducing water consumption and better demand management issues. The WDMU is also responsible about monitoring misuse of water and recommending regulatory measures. The objectives of the WDMU are the following:

- Introducing and promoting the concept of water demand management in the water sector and within other sectors using water. Historically, water sector management focus was mainly supply management.
- Promoting water saving technology and water saving devices. In urban areas, this proved to save at least 20% of water used in buildings. The WDMU offers a free audit program for large consumers.
- Participating in introducing new water laws and regulations that aim to conserve water such as the: “National Jordanian Construction Code: Water Supply for Building Codes” have been updated to address concepts of water efficiency and thresholds for flow rates in water outlets in buildings. Beautification Codes were also updated to introduce the concepts of water savings in outdoor uses of water and concepts of water conserving gardens. Lectures that target design engineers and plumbing technicians to increase awareness of the new codes and their potential water savings were carried out.
- Introducing Water Demand Management concepts at school curricula to increase the younger generation’s understanding about water scarcity and encourage their participation and action.
- Studying of the possibility of greywater reuse in areas with no sewer systems and promoting and supporting studies on rainwater harvesting.
- Carrying outreach activities for creating water conservation culture especially for school children and women.
- Participating in national and international conferences and presenting papers to promote water demand management.
- Promoting the idea of water conserving gardens. The unit has been raising awareness in the field of water conserving landscapes and following up with public parks and nurseries specialized in the propagation of native drought tolerant plants” (Abdelkhaleq 2008).

Although the Strategy does not identify any specific demand management programs, it is clear that the Ministry of Water and Irrigation supports the implementation of demand management efforts

as a necessary part of the long-term solution.

The Water Demand Management Policy is developed to supplement the already existing policies. Its format follows the format as the existing four policies which are published by the Ministry of Water and Irrigation. The National Water Demand Management Policy of Jordan is aimed at influencing and controlling water demand and water usage to achieve a better utilization of the available water resources while meeting the objectives of social and economic development of the country and creating positive environmental impacts. The National WDM Policy is consistent with the Water Strategy of the Kingdom and conforms to its long-term objectives. While the policy is national, it is being implemented by Governmental agencies with the primary responsibilities being vested in the Ministry of Water and Irrigation.

The Water Demand Management Policy addresses the management of water demands in all sectors of the Jordan's economy including municipalities, industry, tourism, agriculture and other activities of national importance. Many provisions of this policy are already in practice. Specific policy statements address the following ten specific considerations:

1. Universal Water Metering and Loss Control (involving tracking of water flows throughout water transmission, treatment and distribution systems with a goal to identify and repair water leaks and increase the proportion of water that is metered and billed to residential, commercial, industrial and public sector users of water).
2. Fulfilling "Unserved" Water Demands (e.g., with a near-term goal to satisfy the presently unmet demands in municipal and industrial uses including the additional water needs of educational institutions and water that is required to support tourism. This goal will be accomplished not only by using the new sources of water, but also by using water savings that are achieved through the ongoing water demand management and water conservation and loss reduction programs, in addition to water recycling).
3. National Plumbing Standards and Water Conservation Codes (primarily the development of a National Plumbing Code including the implementation of National Plumbing Standards with acceptable safety and quality requirements to ensure that all plumbing products are certified thus

preventing the inferior products that quickly deteriorate and cause leaks, or products that are made of inferior materials but are sold as high grade from entering the market in Jordan).

4. Water Pricing and Cost Recovery (e.g., structuring the municipal water and wastewater tariffs to include price incentives for water conservation and setting the price levels to recover the cost of operation and maintenance and the costs of the ongoing necessary capital improvements in water supply systems).
5. Comprehensive Water-Use Information Program (e.g., development and maintenance of a comprehensive national inventory of all water withdrawals and uses, which is essential for understanding the effects of spatial and temporal patterns of water use on the quality, availability and sustainable use of existing water resources).
6. Public Awareness and Education (that is consistent with the Water Strategy for Jordan; an ongoing public information and education program is needed to increase and maintain high levels of public awareness of the importance of water for the well-being of the country and its future economic and social development).
7. Best Management Conservation Practices (e.g., establish a list of water demand best management practices, or BMPs, to be coordinated and implemented by the WDMU at the Ministry of Water and Irrigation).
8. Public Buildings Efficiency Improvement Program (e.g., retrofit of non-conserving plumbing fixtures in all the military, the civil defense, intelligence services, military hospitals, royal palaces and other governmental and public buildings).
9. Water Demand Management Research and Development (e.g., special studies on water use in the municipal, industrial, agricultural and other sectors to support and guide the ongoing water demand management policies and programs).
10. Recognition of Individuals, Institutions and Industry for Advancement in Water Efficiency (with an aim to establish an Annual Water Drop Award to recognize individuals, institutions and other entities for their contribution to the improvements in water-use efficiency in Jordan).

4. Gaps in Water Policies as Related to Climate Change Vulnerability and Adaptation

4.1. Introduction

Climate Change has gained widespread recognition only in the last few years despite the fact that the phenomenon has been set in motion by anthropogenic impacts over the past few decades. It is only in the last few years that the threat from climate change has received attention and the understanding is still evolving. So are the policies and paradigms. The study takes this lag effect into account and reviews Jordan experiences in addressing climate change in its water policies as an opportunity and an on-going process.

In the past, water management relied on the assumption that climatic conditions would remain the same. Presently, there is growing evidence about the impacts of climate change on freshwater availability, water accessibility, water quality and water demand. By 2020, between 75 and 250 million people are expected to face an increase of water stress due to climate change.

The Middle East and North Africa (MENA) region is highly vulnerable to climate change impacts, which add to its already difficult water management challenges. Climate change impacts bring in rise in temperature, drop in rainfall and reduced water availability; reduced ground cover; heat-waves, droughts, floods and storms. This, coupled with current water use patterns and increased freshwater demands, will adversely affect livelihoods and worsen the water challenges already existent in the region. In North Africa, an anticipated temperature increase of 1-3 degrees could expose 6-25 million people to coastal flooding. It is expected that agricultural production would severely be compromised, arable lands, the duration of growing seasons and crop yields are expected to decrease adversely affecting food security, water availability and public health.

Climate change is probably one of the complex and challenging problem facing policy makers today. To effectively incorporate climate change issues into national sustainable development agendas, countries need to develop responsive policies and weigh various potential alternatives under conditions of high uncertainty and consequently recommend specific courses of actions in keeping with the country's economic and socio-political realities.

Climate change increases the urgency for more sustainable water policy and investment choices. Political focus on Climate Change offers opportunities to invest for reduced uncertainty and improved results in water management. Water Demand Management (WDM) is a strategic and effective adaptive strategy to the current challenge of water scarcity and will become more so as climate

change impacts intensify. WDM increases social resilience and contributes to preparedness policies, as opposed to the current responsiveness policies to climate change in MENA. However, there are several difficulties to consider in this process: first, the impact of climate change on the water sector is complicated and -to a large extent- unpredictable. Second, many impacts may be non-linear and chaotic, characterized by surprises and unusual events. Third, climatic change will impose additional stress on water systems.

Through reviewing available published national policies and strategies of water and energy, it was clear that the climate change was not directly addressed. The Energy Sector Master Plan prepared by the Ministry of Energy in 2004 and updated in 2007 dedicated a separate chapter to energy conservation and energy efficiency issues. However, it did not link the mentioned chapter to environmental protection nor to climate change directly.

On the other hand, a National Energy Efficiency Strategy was recently issued and it was linked to environmental protection but, again, not to climate change. A National Water Strategy for the years 2008- 2022 has been issued in May 2009. This strategy outlined needed actions and policies to overcome the shortage of water without taking into consideration the extra impact the climate change will induce.

The findings of Jordan's second national communication (SNC), which has issued in 2009, show how serious and urgent are the challenges we face in the water sector where water resources are expected to decrease based on suggested scenarios. Jordan is currently undergoing a comprehensive assessment and planning process to enhance the adaptive capacity of the water sector to the potential impacts of climate change. Priority actions and choices will be developed within the context of integrated water resource management and the focus on providing adequate water to meet the Millennium Development Goals and national water and environment objectives.

At the adaptation front Jordan is facing a severe challenge in water scarcity to be magnified by the impacts of Climate Change. In a harsh natural environment with limited surface water and heavy demand on groundwater, lack of adequate financial resources for desalination, Jordan is at the front line in the regional fight for innovative solutions to water scarcity problems. The scarcity of water in Jordan is the single most important constrain to the country growth and development as water is not only considered a factor for food production but a very crucial factor of health, survival and

social and economical development.

Through the Second National Communication report stakeholders from different ministries and governmental institutions were involved through the projects' different teams and committees aiming at raising their awareness so that climate change is incorporated into the future strategies and planning of these ministries. Also, as part of the SNC work, a preliminary adaptation action plan was proposed as an initial step to develop a multi-sectoral action plan. The Ministry of Environment is considering getting high level commitment and endorsement of this action plan to help in having the issue of climate change integrated into the strategies and plans of the relevant main sectors.

Through reviewing the existing national strategies for women, poverty, childhood and early childhood development, it was clear that climate change issues were not directly addressed by them. However, it is recommended to include climate change issues in all future updates of these strategies.

4.2. Policy Gap Analysis

To undertake a detailed gap analysis of the Government of Jordan's policies on water, with respect to climate change. This study will fulfill the following:

- Undertake a detailed search of literature on the subject and properly document it in the study annexure;
- Conduct interviews with relevant professionals;
- Review all the water policies that are currently in effect, either as official policy documents or in the form of notifications, speeches, or in any other form;
- Identify gaps in the existing policies, with respect to their relevance to and contradictions of national and international commitments under climate change;
- Make recommendations on how to address the gaps/anomalies in the existing policy framework of agriculture and water, with respect to climate change.

Approach: The study entailed a review of the existing literature relevant to agriculture policy, water policy and the status of various conventions/ protocols into which Jordan has entered. It identifies the gaps in the existing documents and makes recommendations to address them.

Water resources in Jordan are formally managed by the Ministry of Water and Irrigation which oversees two authorities: the Water Authority of Jordan (WAJ) and the Jordan Valley Authority (JVA).

However, there is lack of communication and coordination among the three agencies which results in overstaffing, overlapping in responsibilities and general operational inefficiencies. The new water strategy acknowledges these institutional deficiencies and calls for drastic reformulation (Jordan 2009).

The new strategy (Water for Life) was issued based on vision-driven change effort. This Water Strategy for Jordan identifies plans for future water and the actions that will be taken to ensure that water is available for people, business and nature. It sets the vision of what the sector should achieve by 2022. It looks at all aspects of the water cycle from rainfall to collection, treatment and discharge. The practical steps needed to take include an effective Water Demand Management, an efficient Water Supply Operations and a well developed institutional reform.

The strategy stresses on the need for improved resources management with particular emphasis on sustainability of present and future uses, water protection against pollution, depletion of water resources, achieving the highest practical efficiency in the conveyance, distribution, application and use of water resources. The strategy takes into account both supply and demand management. The strategy ensures that the rightful shares of the Kingdom's shared water resources will be achieved through bilateral and multilateral negotiations and agreements. Jordan's water strategy provided the foundation and initiative to develop policies addressing specific issues facing Jordan's water sector. Four policies have been developed and approved by the Cabinet of Ministers (Ministry of Water and Irrigation, 2002). The institutional and legal reforms are addressed below as relevant to each developed policy.

Jordan water strategy adopts an IWRM approach that emphasize water demand management, reduction in inefficient agricultural activities, involvement of stakeholders especially through water users associations, water quality management, wastewater reuse, and conservative utilization of non-renewable water resources. Although the strategy acknowledges the expected negative impact of climate change on water resources, it does not offer specific adaptive solutions.

All existing national water policies, strategies, and action plans IWRM, relevant to climate change should be reviewed to identify the existing gaps in each water policy issued by the ministry of water and irrigation. This is going to be implemented through defining the excitability of each climatic adaptation measure in the legislation, policy and strategy developed by the ministry.

Despite climate change projections of severe reduction in water resources in Jordan, and other Middle East countries, there seem to be no indication this issue is considered in the current water governance system. In fact, Jordan and other Arab countries are still lagging in reforming their institutional frameworks to deal with the chronic water scarcity. Jordan has prepared a progressive water strategy that, if implemented, will resolve several flaws in Jordan's water governance. However, only a general reference was made to climate change in the document (Water strategy of Jordan, 2009). Water policies and regulations in Jordan is mute on the issue of climate change, despite the mounting evidence of its projected devastating impact on water resources in the region. This is partly due to the general disconnect between the research community and policy makers, and that the latter are not accustomed to keeping up with rapid changes in knowledge as in the case of climate change. Even in more advanced societies, policy makers generally prefer to only acknowledge more established technology and information. However, the highly significant consequences of climate change in Jordan necessitate actively engaging policy makers with the research community.

Governments of the Middle East countries as well as in Jordan have not given climate change a priority that signifies its severe implications to water resources. At best, issues of climate change have been delegated to newly created ministries of environment, which are considered secondary to other posts³. The ministries of environment mostly focus on the mitigation side with little emphasis on water resources. This is mainly a result of the mandate of these ministries, which restrict their involvement in the management of water resources. A more beneficial arrangement is to involve ministries responsible for managing water resources to play an active role on setting climate change policies. This requires both building the capacity to achieve this objective, and more importantly having the political will to pursue this objective.

Setting unequivocal policies on climate change and water resources will pave the way to reform water institutional framework and laws to manage increasing water scarcity and reduce the overall vulnerability of the region to climate change.

As indicated earlier, climate change research in Jordan suffers from underfunding, availability of data and facilities, and the lack of national policies that prioritizes areas of research in climate change. However, the problem is more related to priority setting, and that climate change is either at the bottom of the priority list or not there in the first place. Raising the profile of climate change research on the national agenda requires bringing policy makers closer to the research community.

There are several climate change research gaps that need to be addressed. Several researchers strongly recommended the development of regional climate model that will better capture the influence of the region unique topography on climate. This effort requires however solid basic research and climate modeling expertise, which are absent in the region. This can be only achieved through long-term planning that involves the development of specialized departments and programs in academic and research institutes.

The lack of data and information is another major obstacle in climate change research. There should be a concerted effort to support the development of an extensive network for climate data including utilizing advanced technologies to develop new data networks and rehabilitate existing ones.

4.3. Incorporation of Climate Change Aspects in Water Policies in Jordan

Jordan's water strategy and its water policies are two core documents that need to be updated by including the climate change perspective. The new water strategy stated that "The water scarcity in Jordan poses a serious challenge that will affect all sectors if not addressed with serious efforts. Water for Life is Jordan's Water Strategy that sets the pace for our efforts for the years up to 2022. This strategy establishes Jordan Vision for each of the major areas of the water sector. It also establishes actions required to achieve the Vision. A sincere effort is required from all Jordanians to understand and join collectively to address the water issues that are explained in this Strategy report. It is all the more important to consider this Strategy report and the subsequent action plans as one of the highest priorities to perform on the national level.

1. The Jordan's vision for a water strategy is one whereby 2022, we have:
 - Adequate, safe and secure drinking water supply ;
 - Greater understanding and more effective management of groundwater and surface water;
 - Healthy aquatic ecosystems;
 - A sustainable use of water resources, and implemented fair, affordable and cost -reflective water charges;
 - Adaptation to increased population growth and economic development across the water sector and water users.

2. Water Management has been driven by the necessity to supply water. This Water Supply approach dominated the way water has been managed until now.
3. Groundwater levels have dramatically declined showing that groundwater exploitation in the past was unsustainable. The abstracted amounts in each area need to be limited to the long-term sustainable amount as defined in the Water Resources Management Plan.
4. Despite the huge improvements in infrastructure to supply water, we are facing a critical and serious supply-demand imbalance.
5. A sustainable water supply and demand balance must be secured. This means limiting and even reducing our water consumption, while not ruling out new supply infrastructure.
6. More pressure will be put on our water resources from changes in population, household formation and development, and lifestyles. The increase in demand is witnessed in areas where there is already a lot of pressure on our water resources.
7. The economic development of the past two decades has created enormous pressures on the quality of ground and surface water resources. The process of deteriorating water quality must be halted. This requires that water sources are actively protected from pollution through actions of the Ministry of Water and Irrigation and other involved Ministries/Agencies (i.e. Ministry of Environment), such as setting up and implementing groundwater and surface water protection zones as well as through appropriate landuse planning which takes the need for water resources protection into account.
8. This water strategy outlines a strategic and integrated approach to the sustainable management of our water resources, for the public water supply as well as for the provision of healthy ecosystems and the services they provide. Achieving the vision will have social, environmental and economic implications, which we need to address.
9. This water strategy sets out our vision and key priorities for water. This is a vision – driven effort.
10. The deficit between Supply from Demand in 2007 was 565 MCM.

11. The projected deficit between Supply from Demand in 2022 is estimated at 284 MCM.
12. The water resources of 2007 were 867 MCM and should be developed to 1632 MCM by 2022. The Disi water conveyance is operational by 2013 and the Red Dead conveyance is operational by 2022 and treated wastewater effluent must be fully utilized by 2022. Extraction from groundwater should be drastically reduced.
13. In order to achieve the visions of this Water Strategy, the implementation are set under the following main themes:
 - An efficient and effective institutional reform.
 - A drastic reduction in the exploitation of the groundwater.
 - Efficient use of water resources.
 - Implementation of the Disi water conveyance and the Red Dead conveyance projects.
 - Irrigated agriculture in the highlands will need to be capped and regulated and the by-laws will need to be reinforced.
 - Appropriate water tariffs and incentives will be introduced in order to promote water efficiency in irrigation and higher economic returns for irrigated agricultural products.

Comment: As can be noted from the above water strategy objectives, the recognition of the climate change phenomenon is totally missing. This is a serious flaw and in recent conferences and discussions, both nationally and internationally, climate change has been acknowledged as a serious threat to Jordan's water resources. However, the water strategy of Jordan stated that the "drought management and adaptation to climate change will need to be addressed through proper policies and regulations."

In the context of drought management, currently, three ministries are involved in water supply, management and use: the Ministries of Agriculture, Environment, and Water and Irrigation. NCARTT is involved in drought monitoring, under which integrated water resource management, management information systems (MIS) for crop water requirements, Badia projects, and other related projects would be unified. In general, Jordan has adequate data-collecting institutions for drought monitoring; however, the current response to drought is not institutionalized and has been ad hoc and crisis-oriented without adequate information exchange and coordination. Drought vulnerability assessments are not conducted, nor are any early warning bulletins issued.

Water demand management, as a component of a drought mitigation strategy, remains a challenge in Jordan. Although the Ministry of Water and Irrigation has undertaken several steps to improve water management and use in the country, such as increased water conservation awareness, increased use of water saving technology, replacement of water conveyance pipes, increased use of treated wastewater in agriculture, and a ban on new well licensing, water demand management through water pricing has been instituted in Jordan, particularly in the agricultural sector. Supply of water in Jordan is considered a right by the public, and any manipulation of water demand through pricing is viewed as highly political. Farmers with well licenses pump water, beyond sustainable and allowable levels, resulting in overpumping of groundwater, a drop in water table levels, and a decrease in water quality due to infiltration of brackish water. Although recent attempts to regulate water use and pricing, particularly for private wells, have raised the price. Integrated water resources management remains a challenge for the Jordanian Government since significant changes in the institutional structures would be necessary to enable a more multidisciplinary and integrated approach to drought monitoring and early warning.

In this identification of core issues the strategy is silent regarding the impacts of global warming and changing climates. As can be seen below, apart from noting the high level of variations in the availability of water resources, the strategy does not identify any cause (i.e. global warming), in the absence of which it does not adequately reflect the rapidly changing impacts on water resources. The climate change perspective is indirectly noted in regard to the high variation of water resources, overexploitation of groundwater aquifers and droughts. While not explicit, the strategy indirectly acknowledges that the key issues have a close relationship with climate as a significant driver.

The strategy alludes in its reviews to the Dublin Principles, which set the stage for water resource analysis. The document includes basic data on water, which is not reproduced here. A strategy is typically a concise statement of the broader guidelines to achieve a set of desired goals and objectives within a clearly existing and anticipated environment. An action plan details the actions required to achieve the desired targets. The rest should form part of an implementation plan.

All water policies in Jordan should incorporate clause relevant to Climate Change. The following recommendations should be incorporated in each water policy:

1. Regarding Groundwater
 - Incorporate clause relevant to Climate Change

- Promote groundwater recharge wherever technically and economically feasible. Comment: Groundwater recharge is likely to be reduced by 30-40%, based on the present estimates. However, any increase in rainfall intensity could be reflected in a higher recharge.
- Encourage optimal pumping in water-logged areas to lower the water table. Comment: Climate change that leads to higher temperatures will result in a lowering of the water table in water-logged areas with possible positive impacts on crops grown in such areas (i.e. wheat). Almost 13% of the area under water-logged and saline soils could benefit from a climate change-associated temperature rise. However, this logic should be interpreted with care as some sodic soils may become even worse off under this scenario.
- Delineate areas with falling water tables to restrict uncontrolled water extraction.

2. Regarding Water Quality

- Water quality will be directly impacted due to an increase in temperatures and higher precipitation. The salt imbalance is likely to render water in certain areas no longer fit for human consumption (sea intrusion, brackish water, and waste water). Climate change adaptation measures must ensure that they do not cause a further deterioration in the quality of water through an improvement in the understanding of water biochemistry under temperature rise.
- Resettlement in hotspots due to climate change will be monitored carefully to ensure that this does not lead to deterioration in the quality of water.

3. Regarding Drought Management

- Plan and expedite measures to carry surplus river flows through diversions and other structures to drought-prone areas.
- Pay serious consideration to the need for construction of carry over storages, which is the only effective way of overcoming water shortages during drought years.
- Encourage and support provinces to prepare Drought Management Plans (DMPs) for various drought prone areas.

4.4. Features of Policies Where Water and Climate Change Meet

Water sector issues often intersect and are intertwined with different aspects of climate change, and this is reflected in several water policies. The agricultural sector, in particular, is of importance in efforts to prepare and organize water demand in order to enforce efficiency enhancements to maximize production outputs without disturbing natural flows or utilizing greater (or preferably reduce)

quantities of water in farm activities. Several policies aim at different means to harvest or store water as well as improving irrigation.

Introduction of more resistant crop types are suggested as another way to protect agricultural production from natural disasters like floods. Different ways of disaster management with regard to risk analyses and vulnerability estimations often incorporate impacts of water related natural hazards. Ways to mitigate phenomena like floods, flash floods, mudslides, landslides and heavy rain are present in many strategies. These often incorporate suggestions of concrete actions in form of different engineering efforts such as constructions of levees, dams, control gates, barriers, channels or wadies. On the other side of the spectrum are impacts of water shortages such as drought and desertification normally combated through irrigation efforts and afforestation and promotions of land use alterations. There seem to be widespread awareness of potential risks posed by climate change to development assistance programs related to the water sector. Consequently, policies that suggest development of monitoring functions and prediction of changing hydrological conditions are strategies sought among organizations. Different measures of decentralization are common strategies to address the undefined threats that climate change might pose to the water sector, suggesting that the greatest flexibility and adaptability to cope with swift changes are provided when decisions can be made at the lowest appropriate level.

4.5. Potential Policy Gaps to Fill

The analysis of water policies to tackle the water and climate change challenges indicate that:

1. Integrating climate change, water and energy. An integrated policy framework where climate change, water and energy meet is lacking and should be considered to provide a common analytical and implementation framework.
2. The role of water in key economic sectors. Medium to long term impacts of climate change in key economic sectors (agriculture, energy, water supply) need to be better understood, valued and integrated in current economic planning frameworks due to potential changing hydrological patterns.
3. The water sector is still underinvested in all its aspects. Tackling traditional water services sectors such as WSS, water and agriculture and hydropower production is still critical for building sustainable societies. As these investments are scaled up climate change impacts need to be

stronger integrated in the water governance framework including in planning, design and implementation by both public and private sector actors.

4. Planning for adaptation is urgent. Adaptation to climate change impacts in sensitive areas such as coastal zones, estuaries, and degraded watersheds, and coastal cities is of growing concern. These areas will be most affected by climate change. Sensitive areas and early analysis of multi-sector adaptation strategies need to be promoted and action plans linked to investment prepared.
5. Investment in renewable energy is a good mitigation strategy. Renewable energy investment strategies in the water sector including hydropower (artificial storage and water shed management) and biofuel production where major potential exists is a good mitigation strategy which can bring substantial economic benefits at small, medium and large scale. Further assessments on how to best incorporate feasible renewable energy alternatives at micro levels are needed to avoid social and environmental tradeoffs.
6. Planning systems. Reliable information systems to plan for mitigation and adaptation to climate change are weak. Support to applied research in partnership between public and private sector should be encouraged to build and strengthen capacity to plan for climate change.

5. Proposed Policies for Adaptation to Climate Change

5.1. Introduction

Adaptation to climate change calls for a new paradigm—one that considers a range of possible future climate conditions and associated impacts, some well outside the realm of past experience. Adaptation is a process that requires actions from many decision-makers in government, the private sector, non-governmental organizations, and community groups. However, current efforts are hampered by a lack of solid information about the benefits, costs, and effectiveness of various adaptation options, by uncertainty about future climate impacts at a scale necessary for decision-making, and by a lack of coordination. Therefore, a national adaptation strategy is needed to support and coordinate decentralized efforts. As part of this strategy, the government should provide technical and scientific resources that are currently lacking at the local or regional scale, incentives for local and state authorities to begin adaptation planning, guidance across jurisdictions, shared lessons learned, and support of scientific research to expand knowledge of impacts and adaptation.

The impacts of climate change are closely related to the lives of each and every citizen, and it is expected that the impacts will be even greater in the future. These impacts extend to various aspects of people's lives, affecting the degree to which people can live securely, healthily, affluently and comfortably, and in a way that they can get a sense of culture and history.

The direct impacts on the water environment and water resources appear as changes in the volume of water, water temperature and water quality of each type of water source, including surface and groundwater. These changes influence natural ecosystems and society's water utilization systems and the structure of water demand. A basic relationship between climate change and freshwater is the following: the main climate parameters are water and temperature and the warmer the air the more water can be evaporated and the less left as liquid water.

Climate change will exacerbate concerns about agricultural production worldwide. Food security is prominent among the human activities and ecosystem services under threat from dangerous anthropogenic interference in the earth's climate. Current research confirms that, while crops would respond positively to elevated CO₂ in the absence of climate change, the associated impacts of high temperatures, altered patterns of precipitation, and possibly increased frequency of extreme events such as drought and floods will likely combine to progressively depress agricultural yields and increase production risks in many regions over time, as the severity of climate change increases. It is important for policy makers to develop, together with agricultural stakeholders, a set of metrics for analyzing the magnitude and timing of climate change impacts on agriculture. Such metrics can be used to facilitate the evaluation of policy options, assess the long-term risks of climate change, and to identify potential thresholds beyond which significant adaptation of management techniques may no longer be sufficient to maintain system productivity and income. Impact metrics can help decision makers to evaluate, quantify, and communicate the benefits of climate change policies on agricultural systems. A cohesive set of metrics for climate change and agriculture can also further facilitate operational definitions of vulnerability thresholds for agricultural systems, helping to elucidate connections across biophysical and socio-economic variables.

Impacts on food occur through impacts on the agriculture, and livestock. These impacts include the incidence of white immature grains, reduced quality and taste caused by high temperatures; an increase in frost damage due to the earlier than usual wheat young panicle formation; reduced harvests brought about by shorter ripening periods; an increase in pest damage; and damage caused by hot dry climates. In the fruit industry, reductions in quality and storability, increases in frost dam-

age to horticultural products, and increases in pests have been observed. In the livestock industry, a decrease in impregnation rates, reduced milk yields and poor growth have emerged (CCCIAR).

Impacts of climate change on human health can be broadly divided into: direct effects caused by summer heat; and indirect effects, such as through infectious diseases, air pollution, large-scale natural disasters, harmful insects, and so on. In terms of the effects caused by heat, there have been reports on an increase in the mortality rates of patients with cardiovascular and respiratory diseases, and an increase in the number of heatstroke patients. In terms of infectious diseases, there have been reports on changes in the distribution of vectors of infectious diseases.

The IPCC Fourth Assessment Report refers to “adaptation” as the “adjustment in natural or human systems in response to actual or expected climatic changes or their effects, which moderates harm or exploits beneficial opportunities”. The same report refers to “adaptive capacity” as “the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences”.

Based on the identified adaptation needs, countries identify climate change impacts on ecosystems or regions but more commonly specify the needs by sectors.

Climate change impacts on water resources pose different types of challenges to different regions of the world. Therefore interventions for Jordan should be identified in their National Water strategies, policies and plans. An adaptation strategy should be synchronized with existing environmental, health, social and economic plans, and lead to the implementation of adaptation actions.

The criteria identified in SAR and TAR for the evaluation of policy options (Fischer et al., 1998) as proposed by IPCC are:

- Environmental effectiveness. How well does the policy achieve the environmental goal, such as a GHG emissions reduction target? How reliable is the instrument in achieving that target, does the instrument’s effectiveness erode over time, and does the instrument create continual incentives to improve products or processes in ways that reduce emissions?
- Cost-effectiveness. Whether the policy achieves the environmental goal at the lowest cost, taking transaction, information, and enforcement costs into account.

- Distributional considerations. How the costs of achieving the environmental goal are distributed across groups within society, including future generations.
- Administrative and political feasibility. This includes considerations such as flexibility in the face of new knowledge, understandability to the general public, impacts on the competitiveness of different industries, and other government objectives (such as meeting fiscal targets and reducing emissions of pollutants).
- The literature (e.g., OECD, 1997d) identifies some additional criteria, such as:
 - Revenues raised in the case of market mechanisms, for instance, may constitute a second source of benefits from their use, over and above their direct environmental impact, depending on if and how the revenues are recycled.
 - Wider economic effects include potential effects on variables such as inflation, competitiveness, employment, trade, and growth.
 - Wider environmental effects, such as local air-quality improvement (usually referred to as the ancillary benefits).
 - “Soft” effects, which relate to the impact of environmental policy instruments on changes in attitudes and awareness.
 - Dynamic effects, which relate to the impact on learning, innovation, technical progress, and dissemination and transfer of technology.
 - However, the following recommendation will be implemented in final report:
 - A multi-stakeholder coordination committee should be established to manage national adaptation strategies, chaired by a senior ministry
 - Regulatory issues should be considered from the start of the mainstreaming process

- The capacity of existing poverty reduction and risk reduction mechanisms should be expanded to incorporate climate adaptation where possible
- Governments should ensure that any national adaptation strategy is consistent with existing policy criteria, development objectives and management structures
- Policy-makers should look for policies that address current vulnerabilities and development needs, as well as potential climate risks
- Actions to address vulnerability to climate change should be pursued through social development, service provision and improved natural resource management practices
- A broad range of stakeholders should be involved in climate change policy-making, including civil society, sectoral departments and senior policy-makers
- Climate change adaptation should be informed by successful ground-level experiences in vulnerability reduction
- NGOs should play a dominant role in building awareness and capacity at the local level

The following is an example adopted by the IPCC for national environmental policies instrumentations and evaluations criteria.

Table 1: National environmental policies instrumentations and evaluations criteria (based on IPCC, 2007)

Instrument	Criteria			
	Environmental effectiveness	Cost-effectiveness	Meets distributional considerations	Institutional feasibility
Regulations and standards	Emissions level set directly, though subject to exceptions Depends on deferrals and compliance	Depends on design; uniform application often leads to higher overall compliance costs.	Depends on level playing field. Small/new actors may be disadvantaged.	Depends on technical capacity; popular with regulators in countries with weakly functioning markets.
Taxes and charges	Depends on ability to set tax at a level that induces behavioural change.	Better with broad application; higher administrative costs where institutions are weak.	Regressive; can be ameliorated with revenue recycling.	Often politically unpopular; may be difficult to enforce with underdeveloped institutions.
Tradable Permits	Depends on emissions cap, participation and compliance.	Decreases with limited participation and fewer sectors.	Depends on initial permit allocation. May pose difficulties for small emitters.	Requires well functioning markets and complementary institutions.
Voluntary agreements	Depends on programme design, including clear targets, a baseline scenario, third party involvement in design and review and monitoring provisions.	Depends on flexibility and extent of government incentives, rewards and penalties.	Benefits accrue only to participants.	Often politically popular; requires significant number of administrative staff.
Subsidies and other incentives	Depends on programme design; less certain than Regulations / standards.	Depends on level and programme design; can be market distorting.	Benefits selected participants, possibly some that do not need it.	Popular with recipients; potential resistance from vested interests. Can be difficult to phase out.
Research and development	Depends on consistent funding; when technologies are developed and policies for diffusion. May have high benefits in the long term.	Depends on programme design and the degree of risk.	Benefits initially selected participants; potentially easy for funds to be misallocated. Requires many separate decisions.	Depends on research capacity and long term funding.
Information policies	Depends on how consumers use the information; most effective in combination with other policies.	Potentially low cost, but depends on programme design.	May be less effective for groups (e.g. low-income) that lack access to information.	Depends on cooperation from special interest groups

Note: a Evaluations are predicated on assumptions that instruments are representative of best practice rather than theoretically perfect. This assessment is based primarily on experiences and published reports from developed countries, as the number of peer reviewed articles on the effectiveness of instruments in other countries is limited. Applicability in specific countries, sectors and circumstances – particularly developing countries and economies in transition – may differ greatly. Environmental and cost effectiveness may be enhanced when instruments are strategically combined and adapted to local circumstances.

5.2 Types of Policies for Adaptation to Climate Change

Following are some types of policies used for adaptation to climate changes in general.

5.2.1. Policies for Adaptation With Respect to Environment Effectiveness

Economic and technological uncertainty is reinforced by uncertainties on the physical link between emissions and concentrations. This link is affected by the degree of absorption of gases by the earth and the oceans and the persistence of gases in the atmosphere. Nonetheless, there is less variation in concentrations than in emissions projections because concentrations largely depend on past emissions.

The uncertainty surrounding concentration levels is compounded by the uncertainty concerning the impact of a change in GHGs concentration on temperatures. Environmental uncertainty is generally summarized by the uncertainty around the so-called climate sensitivity parameter, which measures the impact on global mean temperature of a doubling of GHGs concentration from its pre-industrialization level. The uncertainty around this parameter comes from the difficulties to estimate the impact of temperature increases on evaporation rates, which would increase the water vapor concentration (a GHG) and thus, the overall GHG concentration. An increase in evaporation also increases the extent of cloud cover and, in turn, reduces the solar radiation reaching the Earth's surface, thereby lowering the greenhouse effect. Knowledge of the value of the crucial climate sensitivity parameter has improved over time but remains highly uncertain. According to the fourth IPCC assessment report, it is likely (with a probability of at least 66%) to be in the range of 2°C to 4.5°C, with a central ("best" or median) estimate of 3°C. Even restricting the focus of analysis to this "likely" range, the uncertainty on the impact of a given concentration on long-run temperature increases is large. Focusing on this "likely" range for the climate sensitivity parameter ignores the risk of reaching high level increases in temperatures with relatively moderate levels of concentration. For instance, when the whole range of estimated possible values of the climate sensitivity parameter is considered, the probability to reach or exceed a 5°C long-run increase in temperatures with a stabilization of GHG concentration at 700 ppm₁₂ is around 30 % (OECD ?).

5.2.2. Policies for Adaptation With Respect to Cost-Effectiveness

Sectoral studies have shown that in some sectors some adaptation actions can lead to high benefit-cost ratios and/or be implemented at low cost. For example, farm level adjustments, which are assumed to cost very little, can lead to significant benefits in terms of offsetting damages. This is

also the case for other behavioral adaptations, such as enhanced water use efficiency. On the other hand, many adaptations inevitably involve “hard” or infrastructural measures, such as water storage reservoirs and desalinization and waste water treatment facilities in the case of the water sector. Likewise, infrastructural solutions are prevalent in coastal zones, with coastal protection measures, such as dykes and sea walls, representing the main adaptation options considered. Infrastructure adaptation costs are also key in systems that are already critically at risk from immediate climate change impacts, such as high latitude and high altitude systems.

Estimating the costs of climate change impacts and adaptation is inherently problematic, as evidenced by the lack of quantified data on the topic, and the variety in the scale of estimates (sometimes in orders of magnitude) that have been undertaken. Further, these estimates have tended to be based on strong assumptions, such as perfect foresight, and there are very few cross-sector studies that look at the cumulative effects within countries or the wider macro-economic consequences of impacts or adaptation.

Infrastructure must be designed to cope with climate uncertainty. Climate adaptation is value for money in economic terms (that is, in damages avoided). Furthermore, natural infrastructure, such as watershed and wetlands, should be assessed as viable alternatives to the built environment, such as dams and canals.

Cost-benefit analysis of adaptation measures should consider all potential benefits, especially those related to health. Experience in the area of drinking-water supply and human health has shown that a narrow perspective— such as that adopted in the early 1980s for selective Primary Health Care – fails to support a long-term goal.

Several writers have note that there is a serious division between the estimated costs and the actual costs likely to be incurred in implementing a particular GHG program. Such implementation in costs cannot all be easily included in the formal cost assessments but are nevertheless very important in the selection of policies. One method for estimating the adaptation benefits, costs and net benefits is based on optimizing behavior by individual economic agent, i.e. consumers, producers and factor owners. As such it is normative framework, similar to that employed by many governments and international funding agencies to evaluate investments. Optimizing behavior depends on the objectives being perused by economic agents and governments. This definition of optimal adaptation

is based largely on the concept of economic efficiency. This normative framework describes how rational economic agents will respond to climate change in a perfectly competitive economy, and provides a proscription for governments to take action to remove various forms of “market failures”, including the global externality created by GHG pollution.

Recent studies conducted by the World Health Organization (WHO) have demonstrated that taking all co-benefits into account (through social cost-benefit analysis), returns of up to US\$34 can be attained for every US\$1 invested in drinking-water supply (Hutton and Haller 2004). Similar analyses, including health co-benefit studies, should be carried out on adaptation measures aimed at strengthening the resilience of the hydraulic infrastructure.

Technological advances for improving irrigation efficiency, use of lower quality water (including reclaimed wastewater), reduction of system losses from water systems and other developments indicate considerable potential for conserving existing water supplies and for making better use of what is available. These technologies, appropriately adapted to local conditions, must be facilitated, and the capacity to implement and operate them supported.

5.2.3. Policies for Adaptation With Respect to Distributional Considerations

Climate change poses a serious challenge to social and economic development. Developing countries are particularly vulnerable because their economies are generally more dependent on climate-sensitive natural resources, and because they are less able to cope with the impacts of climate change. How development occurs has implications, in turn, for climate change and for the vulnerability of societies to its impacts. Climate change adaptation needs to be brought into the mainstream of economic policies, development projects, and international aid efforts.

An analysis of national development plans, poverty reduction strategy papers, sectoral strategies and project documents in climate-sensitive sectors indicates that such documents generally pay little or no attention to climate change, and often pay only limited attention to current climate risk. Even when climate change is mentioned, specific operational guidance on how to take it into account is generally lacking (OECD 2006).

5.2.4. Policies for Adaptation With Respect to Administrative and Political Feasibility

To grasp the principal politico-economic interactions of adjustment, a coherent framework is re-

quired. These interactions involve four categories of agents: the government, social groups, economic agents (as producers or consumers) and the outside world (international organizations and donor countries).

A wide variety of policies and instruments are available to governments to create incentives for mitigations and adaptations. Their applicability depends on national circumstances and sectoral contexts. These policies and instruments include integrating climate policies to wider development policies, regulations and standards, taxes and charges, tradable permits, financial incentives, voluntary agreements, information instruments, and research development and administration.

To cope with the Copenhagen Agreed Outcomes, the following should be taken into consideration:

- An agreement on adaptation finance is important beyond its significance to supporting adaptation activities in developing countries should be reached, this agreement on adaptation finance is requisite to a Copenhagen Agreed Outcome in part because an agreement on adaptation is necessary for compliance with internationally agreed principles of equity, existing commitments under the Convention and previous decisions by the Conference of the Parties. For the existing trust deficit to be bridged, Parties must first make an effort to mutually understand principles of equity, including common but differentiated responsibilities, polluter pays, and notions of inter- and intra-generational equity. This understanding of what is fair must translate into a joint vocabulary on burden-sharing arrangements (Pearson et al. 2009).
- Uncertainty about the investment and financial flows needed for adaptation should not be used as an excuse for not acting decisively.
- Decisions about the implementation of adaptation activities are the responsibility of individual Parties, based on their national circumstances.
- The allocation of adaptation finance to developing countries must be guided by an assessment based on agreed, objective and measurable criteria.
- A substantial degree of consolidation of international adaptation funding streams is required to ensure an efficient, fair and flexible disbursement process.

- A multiplicity of sources will be necessary to provide adequate levels of funding to meet current and future adaptation needs in developing countries.
- To approach the questions related to the demand, supply and governance of adaptation finance, the country has to address the following three key questions:
- How should adaptation finance be delivered to developing countries, in terms of meeting needs, ensuring fair access, prioritizing particularly vulnerable countries, prioritizing urgent adaptation actions, and ensuring coherence with overall development planning?
- How should adaptation finance be governed, in terms of ensuring appropriate provision of new funds, day-to-day management of the funds, and allocation of funds among eligible developing country Parties?
- How should adaptation finance be generated from existing and new sources, ensuring that they are (at least partly) new and additional, adequate, predictable and sustainable?

5.2.5. Policies for Adaptation With Respect to Wider Economic Effects

What can be meaningfully conveyed to policymakers about the direct benefits of climate policy? Direct benefits refer to avoided climate change impacts, in both monetary and physical terms, from climate change mitigation and adaptation action.

Another type of benefit of climate change policies is known as ancillary or co-benefits (and costs) of climate change policies. For GHG mitigation policies, co-benefits can best be defined as effects that are additional to direct reductions of GHG and impacts of climate change and have estimated to be large, relative to the costs of mitigation (e.g. anywhere from 30% to over 100% of abatement costs). Countries today face numerous environmental challenges, such as climate change, air and water pollution, natural resource management, natural disasters and industrial accidents. The costs of not responding adequately to these challenges can be considerable, in some cases representing a significant drag on the selected country economy.

The uncertainty surrounding the impacts of climate change and, thus, of the benefits of mitigation policies should influence decision making. Economic theory gives some indication for how to

incorporate uncertainty into optimal decision-making. In particular, two aspects of uncertainty are crucial: the interaction between uncertainty and irreversibility, and the risk of extreme events.

Climate change entails some irreversibility. First, since GHGs stay in the atmosphere over periods that can be very long (especially as regards CO₂), the cost of any additional unit of GHG emission is reversible only over the very long run. More importantly, while most market impacts of climate change are likely to be reversible, some of the non market impacts and extreme events that could appear once a threshold is achieved show a large degree of irreversibility. However, the influence of the environmental irreversibility over decisions needs to be balanced against the fact that the cost of mitigation policies is also irreversible (economic irreversibility), which, in the presence of uncertain benefits of policies, justifies to keep open the possibility to take more adequate and less costly actions in the future, and thus, to postpone action. The issue of the “double” irreversibility - economic and environmental - has seldom or only partially been treated in economic modeling. Indeed, studies that incorporate both economic and environmental irreversibility’s only include the environmental irreversibility that comes from the accumulation process of GHG, but not the irreversibility of impacts. It was found that in comparison to this type of environmental irreversibility, the capital or economic irreversibility has a stronger influence on today’s control decisions and that the balance tends to be in favor of postponing actions. The main point is that, unlike the economic irreversibility, the environmental irreversibility coming from the GHG accumulation process is not fully binding since it is possible to decrease atmospheric concentrations in the future by lowering emissions. The environmental irreversibility only holds when the levels of uncertainty and/or concentration are so large that negative emissions are likely to be optimal in the future. On the contrary, the economic irreversibility is binding since it clearly concerns expenditure that is irreversible. Still, it was found that for moderate cost of mitigation policy, the balance is in favor of action. However, none of these studies incorporate the irreversibility of impact, which would tilt more the balance towards action. It has long been recognized that adaptation is critical to enable societies to deal with impacts of both natural and anthropogenic environmental change, especially in low-income countries.

The Stern Review Report (2006) recognized that adaptation to climate change will in most cases provide local benefits, including economic benefits, realized without long lag times, in contrast to mitigation. Adaptation actions should be integrated into development policy and planning at every level, and as Stern emphasis “ignoring climate change is not a viable option – inaction will be far more costly than adaptation” (UNDP 2009).

In general, actions taken to adapt to climate change will generally divert resources from alternative uses. Within the general analytical framework, the purpose of the cost assessment is to translate the effects of climate change action into comparable quantitative units that reflects the impact on society's welfare. In this way the national cost assessment ideally should become an integrated part of a broader national decision framework to climate change adaptation, given the variety of and importance on non-economic factors that will inevitably play a role at every stage of policy formation.

5.2.6. Policies for Adaptation With Respect to Wider Soft Effects

"Soft" Adaptation measures focus on information, capacity building, policy and strategy development, and institutional arrangements.

5.2.7. Policies for Adaptation With Respect to Dynamic Effects

Climate change poses a serious challenge to social and economic development. Developing countries are particularly vulnerable because their economies are generally more dependent on climate-sensitive natural resources, and because they are less able to cope with the impacts of climate change.

How development occurs have implications, in turn, for climate change and for the vulnerability of societies to its impacts. Climate change adaptation needs to be brought into the mainstream of economic policies, development projects, and international aid efforts. Risks such as climate change affect poor people's strategies to secure:

- elements of a basic living standard, including the opportunity to:
- earn an income and meet material needs;
- maintain health and a basic education;
- speak up for oneself and have rights;
- maintain a sense of social and cultural affiliation.

The various processes that lead to failure to secure the four dimensions of basic living standard in the context of climate stress represent a potential interface between poverty and vulnerability to climate change. We define sustainable adaptation measures as those that target this interface, as measures that reduce both vulnerability and poverty address the social dimension of sustainable development. Addressing climate risk, strengthening adaptive capacity, and targeting the factors creat-

ing vulnerability represent what has to be done differently in poverty eradication or development aid in order to adapt to climate change. Empirical evidence shows that climate risks, local capacity to adapt, and causes of vulnerability are all place-specific. Because of the variations in public policy, aid policy, historical, geographical and other factors, there are substantial differences in vulnerability to climate stress across regions and groups. Each specific context demands a different set of measures. Therefore, sustainable adaptation measures must be place specific, and there are no one-size-fits-all solutions that will contribute to both vulnerability reduction and poverty reduction.

Lack of awareness of climate change within the development community and limitations on resources for implementation are the most frequently cited reasons for difficulties in mainstreaming adaptation to climate change within development activity. These explanations may hold true in many situations, but there is also a more complex web of reasons underlying them:

- Barriers within governments and donor agencies: Climate change expertise is typically the domain of environment departments in governments and donor agencies, and such departments have limited leverage over sectoral guidelines and projects. Sectoral managers and country representatives may also face “mainstreaming overload”, with issues such as gender, governance and environment also vying for integration in development activities. Moreover, as many development projects are funded over three to five years, they may not be the best vehicle for long-term climate risk reduction. Adaptation to climate change ex ante may also have more difficulty attracting resources than more visible ex poste activities such as emergency response and post-disaster recovery
- Insufficient relevance of available climate information to development-related decisions: Development activities are sensitive to a broad range of climate variables, only some of which can be reliably projected by climate models. Temperature, for example, is typically easier to project than rainfall. Climate extremes, which are often critical for many development-related decisions, are much more difficult to project than mean trends. There is also a mismatch between the time and space scales of climate change projections and the information needs of development planners. For example, the primary sensitivity of development activities to climate is at a local scale (such as that of a watershed or a city), for which credible climate change projections are often lacking.

Several opportunities exist for more effective integration of climate change adaptation within development activities. These include making climate change information more useful and easier to

use, focusing more on implementing climate change and development strategies, and increasing co-ordination between development and climate change policies.

- Making climate information more relevant and usable: Development practitioners need access to credible, context-specific climate information as a basis for decisions. This includes information on the cost and effectiveness of integrating adaptation measures within development planning. Perhaps even more fundamental is information on the likely impact of climate change and variability on particular development activities. While it would be naïve to call for a significant reduction in scientific uncertainty in climate model projections, more can be done to ensure that this uncertainty is made clear to development practitioners. Analysis of the costs and distributional aspects of adaptation could also assist sectoral decision makers in determining the degree to which they should integrate such responses within their core activities.
- Developing and applying climate risk screening tools: In addition to improving the quality of climate information, tools and approaches are needed to assess the potential exposure of a broad range of development activities to climate risks and to prioritize responses. Also needed are more sophisticated screening tools at the project level, in order to identify the key variables of relevance to the project, how they are affected by climate change and what implications this has on the viability of the project. Field-testing such screening tools and using them in a wide range of project settings could greatly advance the integration of climate risks in development activities.
- Using appropriate “entry points” for climate information: There is a need to identify the appropriate points at which to introduce climate change adaptation into development activities. Potential entry points include land use planning, disaster response strategies and infrastructure design. Environmental impact assessments could be another entry point for mainstreaming both climate change mitigation and adaptation. The implications of projects for greenhouse gas emissions could be included in checklists for such assessments. However, guidelines for environmental impact assessments would need to be broadened to include climate change impacts. Current guidelines consider only the impact of a project or activity on the environment, not the impact of the environment on the project. It is also important to incorporate climate change considerations in planning mechanisms and to ensure that the responsibility for co-ordination lies with appropriate implementation agencies. Furthermore, attention should be given not only to investment plans but also to legislation

- Shifting emphasis to implementation rather than developing new plans: In many instances, rather than requiring radically new responses, adaptation to climate change only reinforces the need to implement measures that already are, or should be, environmental or development priorities. Examples include water or energy conservation, forest protection and afforestation, flood control, building coastal embankments, dredging to improve river flow and protection of mangroves. Often, such measures have already been called for in national and sectoral planning documents but have not been successfully implemented. Reiterating these measures in elaborate climate change plans is unlikely to have much real effect unless barriers to effective implementation of the existing sectoral and development plans are confronted. Putting the spotlight on implementation, therefore, could put the focus on greater accountability in action on the ground.
- Encouraging meaningful co-ordination and the sharing of good practices: Institutional mechanisms need to be developed to forge links between mainstreaming initiated under the international climate change regime and the risk management activities of national and sectoral planners. A corollary link could be between activities initiated to achieve development objectives, such as the Millennium Development Goals, and more bottom-up consideration of the impacts of climate change. Greater engagement of the private sector and local communities in mainstreaming efforts is also needed.

5.3. General Policy Consideration to Climate Change Adaptation

Adaptation measures are undertaken both by public and private actors through policies, investments in infrastructure and technologies and behavioral change. How much adaptation might cost, and how large its benefits might be, are issues that are increasingly relevant both for on-the ground projects, as well as in a global context where trade-offs might need to be considered between the costs of climate policies and the residual damages resulting from climate change.

Policy actions could employ any number of instruments across a wide range of sectors and activities. The one essential criterion, if they are to make a meaningful contribution to the international effort, is that they can be reasonably expected to result in quantifiable greenhouse gas reductions.

Possible mechanisms include goals, targets, performance or technology standards, pricing reforms, and tax and other incentives, among others. They could include policies that:

- Promote energy efficiency and conservation (e.g., energy intensity goals, vehicle fuel economy standards, building codes, appliance standards, industrial efficiency standards);

- Promote low- or no-carbon fuels and technologies (e.g., renewable electricity mandates, carbon capture-and-storage requirements, biofuel targets); or
- Encourage carbon sequestration in land use and forestry practices (e.g., low-till agricultural practices, reduced deforestation).

To make informed decisions about climate change, policy-makers will need timely and useful information about the possible consequences of climate change, people's perceptions of those consequences, available adaptation options, and the benefits of slowing the rate of climate change (Scheraga and Grambsch 1998). The challenge for researchers is to provide this information.

Once policy-makers have received input from the impact assessment community, they must integrate this information into a broader policy portfolio. Response options include actions to mitigate greenhouse gas emissions to slow the rate of climate change; measures to adapt to a changing climate in order to increase society's resilience to the changes that are coming; activities to increase the public's awareness of the climate change issue; investments in monitoring and surveillance systems; and investments in research to reduce key policy-relevant uncertainties.

Climate change, however, should not be considered in isolation from other global environmental stresses. Further, policy-makers usually deal with multiple social objectives (e.g., poverty elimination, promotion of economic growth, protection of cultural resources), while competing stakeholder desires compound the allocation of scarce resources. Climate change should therefore be viewed as part of the larger challenge of sustainable development.

Using the information provided by the research community, risk managers must make decisions despite the existence of scientific uncertainties. Policy-focused assessments analyze the best available scientific and socioeconomic information to answer questions being asked by risk managers. They characterize and, if possible, quantify scientific uncertainties to the extent possible, and explain the potential implications of the uncertainties for the outcomes of concern to the decision makers. Ultimately, it is up to society to decide whether a perceived risk warrants action. But the scientific uncertainty, by itself, does not excuse delay or inaction.

In the assessment of adaptation options, a number of factors related to the design and implementation of strategies need to be considered. These include the fact that:

1. The appropriateness and effectiveness of adaptation options will vary by region and across demographic groups;
2. Adaptation comes at a cost;
3. Some strategies exist that would reduce risks posed by climate change, whether or not the effects of climate change are realized;
4. The systemic nature of climate impacts complicates the development of adaptation policy; and
5. Mal-adaptation can result in negative effects that are as serious as the climate-induced effects being avoided.

Following, we present a brief policies outline for adaptation for climate change:

A. SHORT-TERM POLICIES

- *Exhibit leadership on climate change.*

Strong, consistent, and explicit support for climate change adaptation needs to be infused from the top.

- *Conduct vulnerability assessments and use strategic planning to incorporate climate change into their activities.*

Many land management agencies carry out strategic planning at the agency and parcel level, and such plans consider the consequences of climate change for meeting objectives in the future. Each agency may also need to develop new strategic goals for incorporating climate change into planning, setting priorities, and identifying resource and research needs. Cross-agency strategic planning is needed to identify and resolve cross-agency issues, such as management of adjacent federal lands, water resources, and long-range species migration.

- *Develop effective monitoring systems.*

Monitoring systems are needed to assist agencies in making decisions under uncertainty. Agencies should develop richer information sources for public lands managers.

- *More fully implement adaptive management and ecosystems management, examine anachronistic management paradigms, and integrate climate change into more proactive decision and*

management regimes.

This is one of the most challenging and complicated aspects of climate change adaptation. Following are some of adaptation options for managing ecosystems:

- i. protect key ecosystem features,
- ii. reduce human stresses,
- iii. protect a wide variety of forms of species (representation
- iv. replicate ecosystems,
- v. protect possible species refuges,
- vi. relocate (transplant) species if necessary.

- *Create effective and coordinated research programs.*

Rather than a climate change research and policy assessment capacity agency by agency, a closely networked, multi-agency system of climate expertise should be created.

- *Use the public lands planning and management process as an instrument for testing adaptation strategies and tactics, and informing the public about climate change impacts and adaptations.*

Not only are there significant uncertainties about how ecosystems will be affected by climate change, but there are also many uncertainties on how to aid or facilitate ecosystem adaptation. This combination makes it imperative that land managers be willing and able to experiment with different types of adaptations such as those identified above. The system should encourage prudent risk taking and enable managers to learn from successes and failures, adopting an “adaptive management” approach.

- *Insurance Policies*

Insurance has a dual role with respect to adaptation. Access to insurance payouts can lessen the net adverse impact of climatic events on policy holders. At the same time, insurance is also an instrument for incentivizing adaptations aimed at reducing climate risks. Properly set insurance premiums can, in principle, send appropriate signals to policy holders to undertake adaptation measures to reduce exposure to various risks, including those posed by climate change. On the other hand,

poorly designed premiums that do not adequately reflect the underlying risk can actually impede adaptation or even promote maladaptation. Insurance owes its popularity to notions of economic efficiency, risk aversion, and a sense of solidarity at times of hardship.

B. LONG-TERM POLICIES

- *Examine ways to provide management flexibility while maintaining public input and checks on agency discretion.*

Climate change may require a rebalancing of local and national interests, and new ways of granting site-specific flexibility within national standards and guidelines.

- *Public private partnerships can help provide infrastructure for adaptation and help “climate-proof” existing infrastructure*

Adaptation will put a considerable strain on government resources. Faced with either operational or financial constraints (or both), governments often look to the private sector to enhance their ability to provide public

- *Review and revise legislation to allow for integrated and more unified management of federal lands.*

One way to overcome problems of government owned land management through differing legislative mandates is to craft a single statute for governing management of public natural lands. The statute would allow for multiple objectives and create a standard process for determining and selecting single- or multiple-purpose uses suitable for environmental and societal conditions.

- *Explore changes in how the federal government is organized that can promote a more integrated management of federal lands and response to climate change.*

Among the options are:

- Create a Department of Natural Resources. This would include all agencies. This would facilitate coordination of natural resource management activities and could even allow for consolidation of management functions. On the other hand, it would create a very large and potentially un-

wieldy department.

- Consolidate research and monitoring for environmental change across agencies, and maintain and grow the research infrastructure while ensuring useful outputs by developing climate-aware decision-support tools to increase robust decision making on public lands.

As for the agricultural sector adaptation to climate change, the policy makers should implement the following (OECD 2006):

- Policymakers must introduce and foster the notion of “resilient adaptation” throughout their ministries and agencies as well as in civil society.
- Policymakers must require researchers as well as their own agencies to identify and focus on the protection of Areas of Concern (AOCs) to stop an environmental degradation from becoming a hotspot that will adversely affect food security, forestry and fisheries.
- Explicitly acknowledge agriculture-related controversies and conflicts and then put them into the context of global warming to generate cooperation. Otherwise, proponents will continue see themselves as locked in an apparent zero-sum game with one side winning at the expense of all others.
- Refrain from identifying winners and losers of climate change until objective measures of what it means to win or lose have been identified.
- Keep in mind the Precautionary Principle. In other words, do not use scientific uncertainty as an excuse to avoid decision making when using climate change scenarios for making strategic planning.
- Given the limited funds available, most governments will need to prioritize their adaptive capacity building to climate change impacts and then undertake “adaptation in parts.”
- Additional assessments are needed to discover second-order (downstream) impacts of adaptation and mitigation strategies and tactics.

- Call for and support an assessment that identifies both the obvious and the hidden reasons why hazard-and disaster-related lessons are identified after each disaster but are often not applied (used).
- Require that all new projects affecting the environment, including forestry and fisheries, include a “Food Security Impact Assessment” (FSIA).
- Policymakers must be made aware of the importance of changes in seasonality and must consider this a high priority concern about climate change, since people and economies are align with the expected natural flow of the seasons.
- Consider prevention along with mitigation and adaptation because new activities that are known to produce greenhouse gas emissions can be blocked.
- Policymakers must harmonize the activities of their ministries, agencies and bureaucratic units with the rules used to govern administrative jurisdictions.

The role of the government policies related to adaptation to climate change will cover the following:

- In the food sector, the government should develop mechanisms to support and advice on adaptation measures. In addition, provide information and human resources development to promoters of agricultural improvement and farming advisors.
- In water environment and water resources side, the government should work on improvement of water supply to different sectors. Moreover it should put restrictions of deep groundwater pumping and raise water-saving awareness.
- In natural ecosystems, the government should conduct the following:
 - o Reconsideration and new designation of natural reserves, national parks, etc.
 - o Regulations of artificial transportation
 - o Restrictions on tourist activities
 - o Training volunteers with knowledge and skills who are able cooperate in monitoring

- In the health Sector, the government should establish institutions and regulations for heat stroke prevention, provide care for elderly households and raise public awareness on health care.

Ramifications refer to aspects of policy that, if neglected, would yield negative feedback to policymakers. The question that policymakers must ask is “what are the consequences of not doing this suggestion?”

- Every country needs to prioritize its hazards according to its own criteria, such as in terms of likelihood of occurrence and severity of impacts on citizens, infrastructures and ecosystems.
- The overriding objective for focusing on food security related to hotspots is to avoid creating new hotspots where they do not yet exist.
- Policymakers must not panic as they prepare for changes in the near and long term.
- Adaptation to change has to be appropriate to specific hazards or threats for a given period of time.
- There has been no attempt to systematically identify, region by region, which climate changes might be advantageous and which might be harmful.
- Decision makers must maintain a degree of flexibility in the implementation of their adaptation and mitigation strategies and tactics.
- Consideration must be made of how adaptation in one sector might affect the possibility for effective adaptation in another sector.
- Resist the pressure on decision makers to go for short-term benefits at the expense of long-term costs.
- Foster a cross-sectoral (multidisciplinary) approach that matches cross-sectoral aspects of and need for adaptation and mitigation. Such an approach will foster a broader, more appropriate approach to adaptive capacity building.

- Assure awareness and dissemination of conference and workshop proceedings about adaptation and mitigation to produce understanding and to reduce fear among both the general public and professionals.
- Policymakers must not only enhance agriculture's mitigation role but must also reduce the vulnerability of poor and marginalized people to food insecurity.

5.4. Integrated Water Resources Management – An Intelligent Strategy for Adaptation

Climate change is expected to impact global water resources with present regional changes in the frequency and intensity of extreme weather events already being attributed to the changing climate. Moreover, evidence suggests that those countries already facing water stress (rather than just water scarcity), especially in Africa, will be particularly hard hit by changes in the hydrological cycle. Despite advances in regional modeling, predicting climate change impacts on water resources is exceedingly difficult, in part because water resources are not only shaped by the hydrological cycle but changes in population, technology, and the social, economic and political landscape. Rising population, urbanization, pollution, changing agricultural sectors, and institutional and legislative conditions are only some of the diverse factors that ultimately determine future water demands. However, one fact remains -- that is for sure is that climate change will add further uncertainty to water resources management. This section will briefly describe some of the predicted climate change impacts on water resources and the need for climate change to be included in water resource planning. Furthermore, the section will explore how climate change adaptation can be included in water management, in particular, through Integrated Water Resources Management (IWRM).

The IPCC concludes that climate change will lead to an intensification of the hydrological cycles affecting both ground and surface water supply. Changes in the temperature, the frequency and intensity of precipitation and timing of runoff, as well as the intensity of floods and droughts will all have regional impacts on water supply and water quality. This, in turn, will affect domestic and industrial water supply, irrigation, hydropower, navigation, ecosystems, and tourism. The impact on irrigation is especially important since agriculture currently accounts for about 70 percent of water consumption worldwide, with the UN projecting a 50 to 100 percent increase in irrigation water by 2025.

At present, there are no water management options that are uniquely suited to adaptation to cli-

mate change that “would be measurably different to those already employed for coping with contemporary climate variability”. Adaptation to climate change will call upon existing strategies in water management; fortunately, there are a wide range of tools and strategies available within the field, both structural and non-structural. This section cannot hope to describe all; however, these approaches can be summarized into two main streams: supply-side and demand-side management. Supply-side water management represents the traditional approach in water policy: trying to increase the supply and access to water through technology, operating rules and even institutional changes. On the other hand, demand-side management aims to improve the more efficient use of existing water resources. Such approaches include more efficient irrigation practices and changes in water rights and allocation. In general, demand-side adaptation is thought to be more environmentally sustainable and cost effective, especially for poorer countries lacking the finances for large-scale technological solutions. Furthermore, the literature suggests that demand-side measures are better for tackling the underlying problems of water scarcity. However, supply-side adaptation is still important, and represents the dominant policy approach in many countries (especially in the Middle East and North Africa region). Research into climate change adaptation policy draws upon both supply- and demand-side approaches.

Many within the water research community believe that water resources management, especially the tools of Integrated Water Resources Management, can accommodate the further uncertainties that climate change will bring to the water sector. Indeed, “finding ways to deal with greater uncertainty in water management can act as a catalyst for innovation”.

Many operating in the water research community, especially those advocating Integrated Water Resources Management (IWRM), are exploring innovative demand-side strategies for tackling growing water scarcity; however, a paradigm shift is needed in many governments’ policy (Kabat, et al., 2002). Climate change science could help support this push for IWRM and reinforce ongoing reform in the water sector.

5.4.1. What is Integrated Water Resources Management (IWRM)?

IWRM is the sustainable development, allocation and monitoring of water resource use in the context of social, economic and environmental objectives (Cap-Net, 2005). It is cross-sectoral and therefore in stark contrast to the traditional sectoral approach that has been adopted by many countries. It has been further broadened to incorporate participatory decision-making of all stakeholders.

IWRM is a paradigm shift. It departs from traditional approaches in three ways:

1. The multiple goals and objectives are cross-cutting so that IWRM departs from the traditional sectoral approach.
2. The spatial focus is on the river basin instead of on single water courses.
3. It entails a departure from narrow professional and political boundaries and perspectives, broadening them to incorporate participatory decision-making among all stakeholders (i.e., inclusion versus exclusion)

5.4.2. Importance of IWRM for Adaptation to Climate Change

Water is the first sector to be affected by changes in climate. Climate change leads to intensification of the hydrological cycle and subsequently it has serious effects on the frequency and intensity of extreme events. Sea level rise, increased evaporation, unpredictable precipitation and prolonged droughts are just a few manifestations of climate variability directly impacting on availability and quality of water.

Through management of the resource at the most adequate level, the organization of participation in management practices and policy development, and assuring that the most vulnerable groups are considered, IWRM instruments directly assist communities to cope with climate variability. In 2001 the Intergovernmental Panel on Climate Change (IPCC) recognized the potential of IWRM to be used as a means of reconciling varied and changing water uses and demands, and it appears to offer greater flexibility and adaptive capacity than conventional water resources management approaches. It is critical that climate change in water governance be considered in the context of reducing vulnerability of poor people, in maintaining sustainable livelihoods and supporting sustainable development. The IPCC report makes recommendations on adaptation, vulnerability and capacity enhancement; the main recommendation asserts that reducing the vulnerability of nations or communities to climate change requires an increased ability to adapt to its effects. Working to improve the adaptive capacity at community level is likely to have a broader and more long-lasting effect on reducing vulnerability. Tailoring adaptation assistance to local needs requires the following actions:

- Addressing real local vulnerabilities;
- Involving real stakeholders early and substantively; and
- Connecting with local decision-making processes.

5.4.3. How Can IWRM Help Addressing Climate Change?

As demonstrated earlier in this chapter, IWRM offers various tools and instruments that deal with

access to water and protecting the integrity of the ecosystem, thus safeguarding water quality for future generations. In this way, IWRM can assist communities to adapt to changing climatic conditions that limit water availability or may lead to excessive floods or droughts.

Key water resources management functions are:

- Water allocation;
- Pollution control;
- Monitoring;
- Financial management;
- Flood and drought management;
- Information management;
- Basin planning; and
- Stakeholder participation.

These functions are instrumental for integrated resources management and can be of help in coping with climate variability. For example:

- In monitoring water quantity and quality developments, management can pro-actively take action towards adaptation.
- Management of floods and droughts, as a key function of WRM, allows for direct intervention in cases of extreme events.
- In basin planning, risk assessment and adaptation measures can be incorporated.
- Water can be allocated to the most efficient and effective use to react to climate variability in a flexible manner.

In brief, IWRM makes it easier to respond to changes in water availability. Risks can be better identified and mitigated in the process of basin planning. When action is needed, stakeholder participation helps to mobilize communities and generate action. Water users can be stimulated to use the resource sustainably in the face of changing water conditions.

5.4.4. Integrated Water Resource Management and Climate Change Adaptation

Within the literature, Integrated Water Resource Management (IWRM) is recognized as the most promising approach to managing water resources, especially in a changing environment and with changing water demands (Kabat et al., 2002; IPCC, 2001). IWRM also offers a solid platform from which to base climate change adaptation policy within various water sectors. It should be noted, however, that despite the recognized merits of IWRM, in reality it has often proved difficult to implement on the ground.

IWRM “involves three major components: explicit consideration of all potential supply-side and demand-side actions, inclusion of all stakeholders in the decision process, and continual monitoring and review of the water resource situation” (IPCC 2001, ch. 4, p223). As explained in earlier chapters, tackling current vulnerabilities to climate variability and deficiencies in water management is the best starting point for climate change adaptation policy. For example, more research is needed to enhance the preparedness of water systems (i.e. regarding risk assessment, watershed management, and increasing water storage in cases of flood and drought) and climate change adaptation can target such areas for improvement. Furthermore, as advances are made in climate change models, greater dialogue is needed among meteorologists, water managers, and climate change modellers to act on new knowledge and feedback into the climate change models (Kabat, et al., 2002). Tackling the current ‘adaptation deficit’ to water and adopting interdisciplinary and multi-faceted approaches such as IWRM will go along way to increasing the ability for communities and countries to adapt to future climate change (IPCC 2001; Kabat et al, 2002). The biggest problem associated with IWRM is that this holistic management style can be extremely costly and time consuming, hindering its use in poorer countries and communities. Moreover, there is a decline in meteo-hydrological networks in many less developed countries and “even the most basic indicators [used for water management including river discharge, rainfall, and subsistence irrigation] are generally becoming more and more scarce” (Bergkamp, et al., p34). As such, climate change adaptation will require that these issues be addressed, and this may be one area where the climate change and water communities can reinforce each other.

Better water management will be essential if communities are to adapt successfully to climate induced changes in their water resources. The strategies adopted will have to use a combination of “hard,” infrastructural, and “soft,” institutional, measures and to go well beyond what is normally considered as “water business”. Critically, they will require major changes in the way agriculture, industry and human settlements in general are managed. The future resilience (or vulnerability) of human communities to climate change related impacts will depend, in large measure, on their success. This brief suggests that the IWRM approach provides a framework for action, indeed that the best approach to manage the impact of climate change on water is that guided by the philosophy and methodology of Integrated Water Resources Management (IWRM).

IWRM promotes a holistic approach to water management and recognizes that there are multiple pathways to building resilience. The methodology seeks to identify, and then to achieve tradeoffs

between, different water management objectives including environmental sustainability, economic efficiency and social equity. It encourages the structured engagement of communities and sectors impacted upon by water into its management both to seek and promote “win-win” solutions but also to ensure that a better understanding of water constraints and challenges is developed and diffused into the society.

IWRM involves both “hard” infrastructural and “soft” institutional strategies. Indeed, it is the judicious mix of both hard and soft strategies that offers countries the best chance of coping successfully with climate variability and change, through the use of soft tools that complement infrastructure and help ensure that infrastructural investments work effectively.

5.4.5. Soft Strategies - Institutions and Management Systems

The armory of the water manager to address variability and extreme events is not restricted to infrastructural means. As important are the institutional mechanisms that, again more or less formally, help to deal with climate variability and to achieve goals such as water supply for people, industries and farms, to protect communities from flooding while sustaining ecosystems.

Integrated water resource management also offers a set of soft tools that are often cheaper, and may be more effective, than its infrastructural tools and can certainly complement infrastructure to ensure that it works effectively.

Thus, in addressing potential water shortages, as much attention should be given to managing demand as to increasing supply, by introducing more efficient technologies as well as simply promoting a culture of conservation. This is going to be particularly important in areas where overall water availability declines.

In many countries, this is already done in a rudimentary way. Organized drought restrictions in agriculture and “hosepipe bans” for domestic users should not be seen as supply failures but rather as institutional mechanisms used to manage variability by prioritizing different water uses at times of supply stress.

An important element of demand management is to encourage water users to use what they have more efficiently. It has been widely demonstrated that, with help and encouragement, well-off

households can substantially reduce their consumption. Farmers can usually get far more “crop per drop”; industrialists often achieve more production per unit water when put under regulatory pressure and can also locate water intensive processes in areas where water is plentiful. Incentives for water users to exchange their current water allocations, either through administrative systems or “trading,” can help to achieve more efficient water use, although the social impacts need to be carefully managed.

At a larger scale, the global trade system has a substantial impact – positive and negative - on water use, which needs to be understood and engaged (see Box “Kenya’s water-wise roses”). In this context, the current promotion of biofuels as a source of energy could greatly aggravate the challenges of water scarcity if not carefully planned and regulated.

Beyond direct water management, institutional instruments such as land use planning can substantially reduce the vulnerability of communities to water based natural disasters if they are informed by reliable flood data. This demonstrates that there is often a choice from a suite of hard and soft instruments that can be applied to enhance resilience. Thus resilience against floods can be achieved by building protective infrastructure or through planning which restricts settlement in vulnerable areas.

In all this, it is important to recognize that many of these challenges are not new and are certainly not the product of climate change alone. Thus the changing lifestyles and dietary patterns associated with growing affluence in countries like China and India will, arguably, have an even greater and more immediate impact on the water environment.

5.4.6. How to Incorporate The Climate Change Dimension into National IWRM Plans?

At the World Summit on Sustainable Development in 2002, countries committed to the development of national IWRM and water efficiency plans that were included in the Johannesburg Plan of Implementation (UN, 2002). This has been instrumental in taking the development and implementation of IWRM forward in national agendas, and many countries have initiated or further strengthened national processes for the development of such plans.

The Cap-Net Training Manual and Operational Guide on Integrated Water Resources Management Plans (Cap-Net, 2005b) presents the process in seven sequential steps as outlined in Figure 7.1.

When viewing the IWRM planning process as instrumental for adaptation to changing climatic conditions, the following may be considered:

- In the 'Initiation' step, climate change impacts need to be integrated in the planning process. In advocacy towards policy makers, the argument can be brought up that this will be instrumental for decision makers to advance demand management strategies, which otherwise might be politically difficult to implement.
- During the 'Vision/policy' phase, climate change adaptation is an additional element, not a replacement of IWRM goals. The overall aims of IWRM will remain the same.
- In the 'Situation analysis' step, the use of climate information and impact analysis needs to be incorporated. Further, the adaptation/mitigation theme can be brought out to suggest that the IWRM process should reduce the risk of adaptation options negatively impacting on the mitigation targets, and vice versa.
- In the 'Strategy choice' phase, the anticipatory or 'precautionary' approach can be introduced as the basis for strategies for IWRM.
- Consider the roles of local authorities and river basin organizations (RBOs) in adaptation strategies when drafting an IWRM plan.
- Legal frameworks, economics and health, and other variable conditional elements that have been analysed from the corner stone for implementation of IWRM and are decisive in how it contributes to climate change adaptation.
- During evaluation, results must be measured against indicators, taking into consideration the adaptation measures proposed in the plan.

Throughout the process, stakeholder involvement is essential so that the results of the impacts assessment and strategic choice are owned by the implementing agencies. The range of solutions and strategies has been broadened over time by improvements in technologies. What has changed is our understanding and implementation of the integrated ensemble of water management measures that conform to modern principles and policies. A catchment is composed of many users, who reside

upstream and downstream of each other.

5.4.7. Strategy Development and Planning for Adaptation

Jordan has distinguished experience in the region in water policy formulation especially with regards to demand management, stakeholder participation, and public-private partnerships that are considered major achievements towards IWRM implementation. Nevertheless, there are some challenges that may impede policy implementation, for example, institutional roles of all actors are still not well defined, there is still a need for updating existing laws that regulate groundwater abstraction and more importantly the inadequate technical and institutional capabilities in the water sectors. Moreover, insufficient financial resources and the carrying capacity of water infrastructure may further delay policy implementation.

IWRM is the key process that should be used in the water sector for water-related developments and measures, and hence for achieving the water-related MDGs. However, the potential impacts of climate change and associated increasing climate variability need to be sufficiently incorporated into IWRM plans. IWRM should form the encompassing paradigm for coping with natural climate variability and the prerequisite for adapting to the consequences of global warming and associated climate change under conditions of uncertainty.

Adaptation is a process by which individuals, communities and countries seek to cope with the consequences of climate change, including climate variability. It should lead to harmonization with countries' more pressing development priorities such as poverty alleviation, food security and disaster management. Management of land and water resources presents the major input in addressing all development priorities; therefore, IWRM planning processes must incorporate a dimension on climate change adaptation. The following subchapters outline the elements of guidance available from a range of key international institutions engaged in the adaptation debate. The need to address climate change and increasing climate variability is a comparably new issue in the global water debate. Although the increase in extreme events was identified as a new challenge for water managers in Agenda 21 of the 1992 UN Conference on Environment and Development (the Earth Summit) in Rio de Janeiro (UN, 1992), this was not explicitly linked to climate change or increasing climate variability; it recommended a comprehensive set of measures for the water sector. The Implementation Plan of the 2002 World Summit on Sustainable Development (WSSD, 2002) reiterates that these recommendations are still valid today.

The United Nations Economic Commission for Europe (UNECE), under its Convention on the Protection and Use of Transboundary Watercourses and International Lakes, has embarked on a process to develop a guidance document on Water and Climate Adaptation (UNECE, 2009). Although it is presently available only in draft form, it provides a good synthesis of the current policy debate on the issue and the requirements and broad steps involved in adaptation planning for the water sector. The steps involved in developing an adaptation strategy are outlined in Figure 1.

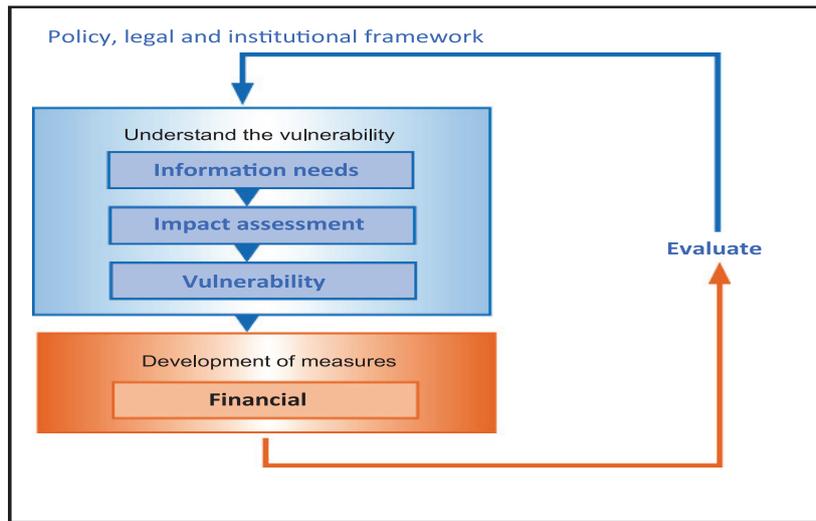


Figure 1: Development of an adaptation strategy (UNECE, 2009)

The guidance document (UNECE, 2009) proceeds to outline some major principles for adaptation planning, namely:

1. Climate change is a process characterized by a number of uncertainties and risks relative in particular to the magnitude, timing and nature of the changes. However, decision makers are not used to such uncertainty when dealing with other problems. To take into account this situation, various methods should be used. These include sensitivity analysis, risk analysis, simulation and scenario development.
2. As climate change raises threats of harm to human health and the environment, the precautionary principle should be applied and preventive actions should be taken even if some cause-and-effect relationships are not yet fully scientifically proven. According to the precautionary principle, uncertainty about the damage to be incurred should not serve as an argument to delay action. In the face of great uncertainty, a precautionary approach might even result in a more stringent emission-reductions target and/or adaptation response.
3. The following overarching principles should apply to any adaptation policy framework:
 - Adaptation to short-term climate variability and extreme events is a basis for reducing vulnerability to longer-term climate change;
 - Adaptation policy and measures are assessed in a socio-economic development context;
 - Following the principles of sustainable development adaptation policy and measures take social, economic and environmental concerns into consideration and ensure that the needs of the present generation are met without compromising the needs of future generations; and
 - Adaptation policies/strategies are elaborated at different levels in society, including the local level.
4. Strong interdepartmental (interministerial) and intersectoral cooperation with the involvement of all relevant stakeholders should be a precondition for decision-making, planning and implementation.
5. IWRM should be applied to ensure the multi-layered integration of management in which existing approaches are distinct from one another and take into account the environmental, economic, political and sociocultural conditions of the respective region.

6. No-regret and low-regret options should be considered as a priority. No-regret options are measures or activities that will prove worthwhile even if no (further) climate change occurs. For example, monitoring and early-warning systems for floods and other extreme weather events will be beneficial even if the frequency of the events does not increase as expected. Low-regret options are low-cost options that can potentially bring large benefits under climate change and will have only low costs if climate change does not happen. One example is accounting for climate change at the design stage for new drainage systems by making pipes wider.
7. The selection of scenarios and related methodologies and measures to deal with adaptation to climate change should take into consideration possible side effects of their implementation.
8. Measures to cope with the effects of climate change have to be taken into account at different scales, both in space and in time. Regarding the spatial component, measures should account for local issues as well as regional and basin-wide issues. Regarding the time component, distinctions should be made between the strategic, tactical and operational levels.
9. Estimating costs of a measure is a prerequisite for ranking a measure and including it in the budget or in a wider adaptation programme. The four major methods used for prioritizing and selecting adaptation options are cost-benefit analysis, multi criteria analysis, cost-effectiveness analysis and expert judgment. The costs of non-action that could lead to a number of environmental and socio-economic effects (e.g. lost jobs, population displacement and pollution) should also be considered.

While the above generic principles are necessary to guide adaptation policy, they do not say much about translating policy into action. As countries begin to report on their achievements in the UN-FCCC context, they provide case scenarios on adaptation planning and practice, and it will be necessary to synthesize information gained from them. For the purpose of this manual, an example case is provided in the exercises for this chapter that shows one option how to move from principles to practice in form of an adaptation planning project in an arid developing country context.

5.4.8. Implementing IWRM

While there has been progress in a general understanding the meaning of IWRM, its importance in the context of scarcity, an acknowledgement of the main (Dublin) principles and a growing recogni-

tion of the need to use the right mix of economic and financial instruments, the actual implementation of IWRM is a challenging process.

There are several roadblocks to implementing IWRM, starting with entrenched sectoral interests, professional insecurities and sociocultural myths. These challenges are nevertheless not insurmountable. Overcoming the barriers to the implementation of IWRM requires an incremental approach to negotiating differences, cross-sectoral integration and instituting reforms (including policy and legal reforms).

Conflicts among professionals working in the various sectors, combined with a sense of vulnerability in adopting alternative approaches to water development and management that permeates professional groupings, calls for skills in negotiating win-win solutions and providing platforms for very different stakeholders to develop collaboration in implementing IWRM. These processes take time and require patience.

IWRM can only be successfully implemented if, among other reforms, there is a concerted effort to integrate perspectives and divergent interests of various water users in the management framework. Formal mechanisms and means of cooperation and information exchange should be established at different levels to achieve cross-sectoral integration. Past informal attempts have not been successful, and a formalized set of mechanisms should have the effect of ensuring commitment at the various levels. Uncertainties are part of a shift in the management paradigm and the process of implementation considers dealing with them.

Existing institutional and legislative frameworks have not been entirely responsive to the demands and requirements for implementing IWRM. Implementing IWRM will therefore require reform at most stages in the water planning and management cycle.

Although there is an urgent need for reform, these changes can only take place incrementally – some occurring immediately and others taking several years of planning and capacity building. It will involve creating an enabling environment, and developing an institutional framework and management instruments for sustainable IWRM.

5.4.9. Climate Change in IWRM Planning

Historically, at the core of water management has been its adaptive capacity and capability. Previously, management practices responded to particular situations or needs arisen from changing circumstances that could be brought on by natural causes, institutional changes, political priorities, and other factors. From that perspective, adaptation and coping strategies for climate change are not new or devoid of basic water management practice principles.

Management options for adaptation to climate change are not unique or specifically different from those already employed for coping with contemporary climate variability. The only substantive difference is whether one adopts a more conventional and incremental ‘no-regrets’ approach, or a more anticipatory and ‘precautionary’ approach. This is one argument for the use of IWRM as an instrument for adaptation. Perhaps more important is that IWRM is a response to the question, how to work through water management to achieve the Millennium Development Goals? In this context, it has been rightly suggested that while energy habits are the focus of climate change mitigation, IWRM should be the focus of adaptation (Jonch-Clausen, 2007).

a. Institutional Framework

For many reasons, developing country governments consider water resources planning and management to be a central part of government responsibility. This view is consistent with the international consensus that promotes the concept of government as a facilitator and regulator, rather than an implementer of projects. The challenge is to reach mutual agreement about the level at which, in any specific instance, government responsibility should cease, or be partnered by autonomous water services management bodies and/or community-based organizations.

The concept of integrated water resources management has been accompanied by promotion of the river basin as the logical geographical unit for its practical realization. The river basin offers many advantages for strategic planning, particularly at higher levels of government, though difficulties should not be underestimated. Groundwater aquifers frequently cross catchment boundaries, and more problematically, river basins rarely conform to existing administrative entities or structures.

In order to bring IWRM into effect, institutional arrangements are needed to enable:

- The functioning of a consortium of stakeholders involved in decision making, with representation of all sections of society, and a good gender balance;

- Water resources management based on hydrological boundaries;
- Organizational structures at basin and sub-basin levels to enable decision making at the lowest appropriate level; and
- Government to co-ordinate the national management of water resources across water use sectors.

New institutional settings and reforms need to be carried out for the successful implementation of the IWRM plans. These reforms may include: re-structuring the role of water institutions, decentralization and providing more water management authority to water users, stimulate co-ordination among water sector stakeholders through joint activities and shared investments, co-ordination of financial resources on the de-central and central levels, enhancing the role of Water User Associations, Water Boards, NGO's, Civil Society, etc. In the Jordan, to implement IWRM plans, an implementation framework that includes a clear description of roles and functions of the organizations involved in the implementation process, time schedule, level of responsibilities and relation to other stakeholders, communication channels and investment and monitoring plans, need to be established (UN ESCWA, 2005).

In addition, water laws and legislative instruments are essential and powerful tools for formulation and implementation of IWRM plans. The legislation and regulation systems (e.g. laws, by-laws, rules, decrees, agreements, etc.) should deal with all water uses, monitoring of water quantity and quality, water allocation for various functions and sectors, water rights, etc). In many countries in the ESCWA region, water-related laws are insufficient, ineffective and outdated. There is a need to create modern water legislative instruments to support the implementation of IWRM plans. More efforts are still needed to revise and modernize existing laws and to strengthen the institutional reforms needed for implementation of the IWRM plans in many countries in the ESCWA region.

This report is mainly focused on the following : (a) assessment of present status of institutional and legislative settings and appropriateness to implement IWRM plans; (b) identification of institutional and legislative challenges, constraints and gaps that hinder the implementation of IWRM plans in the country and assessment of opportunities; (c) proposal of scenarios and alternatives for the implementation of legal and institutional reforms and ultimately the IWRM process; (d) review of institutional and legislative measures undertaken in Jordan.

Jordan gets its water from a diversity of sources. The Jordan and Yarmuk Rivers are the major sources of surface water, but they have become unpredictable in recent years due to upstream damming and diverting by Israel and Syria, respectively.¹⁶ Underground water from non-renewable aquifers and treated wastewater also contribute to Jordan's water supply.¹⁷ There are approximately 2,000 groundwater wells in Jordan, of which half are illegally constructed, further exacerbating the problem of water overexploitation.

The Water Authority of Jordan privatized its water and wastewater services in Amman in 1999 with the help of LEMA. LEMA is a Jordanian company with shares that are owned by Suez Environment, a French water service company, and MWHAJ, a regional engineering consultant company specializing in water. In 2007, LEMA transferred control of Amman's water and sewage systems to the commercial government-owned Jordanian water company, Our Water Miyahuna. There has been some criticism of the privatization efforts, with critics claiming that the private companies have not reduced the amount of unaccounted for water or improved water quality, as was promised in the contracts. The privatization scheme does, however, have the possibility to supply water efficiently if it is based on effective strategic planning and accompanied by efforts to clearly define its public objectives.

b. Regulatory Aspects

In accordance with MWI strategy and policies, national health standards are to be promulgated and enforced. This is particularly for municipal water supply. Compliance to these standards ought to be ensured regularly by utility owners through laboratory testing. Records of tests should be maintained and be available for inspection by the governmental agencies. National drinking water standards are listed in the Jordanian Standards for Drinking Water No.286 of 2001. There are also guidelines for microbiological water quality of raw water intended as a source for treatment to drinking water levels (Unpublished). Other relevant standards include those; Jordanian Standards for Reclaimed Domestic Water No.893 of 2002, Jordanian Standards for Industrial Wastewater No.202 of 1991, WAJ's Regulations for the Quality of Industrial Wastewater to be connected to the Collection System. Each of the WAJ Central Laboratories in Amman, JVA Laboratory in the Jordan Valley and Ministry of Health Laboratory has separate surveillance and monitoring programs for water and wastewater. The Ministry of Environment doesn't have its own laboratories but nonetheless contract others to execute its monitoring legislative duties.

1. The central government has the greatest influence on managing the water sector. Local municipalities and special authorities have some influence but much less than that of the central government. This is particularly so for the municipal sub-sector and to a lesser extent in cases of the agriculture and industrial ones. Management responsibilities are divided among the various departments. These departments are created mainly on geographical considerations and a lesser extent, on political considerations, catchments areas or river basins and utilization patterns. There seems to be reasonable degree of coordination between these departments.
2. The present administrative set-up is fairly seen to be favorable to efficient water sector management. Private sector involvement is seen to have a positive impact on water sector performance.
3. The allocated water budget is seen to be insufficient to achieve water sector objectives. Private sector participation isn't seen highly capable of reducing this deficit.
4. The government is the only side that determines and controls water tariffs.
5. On regulatory procedures, monitoring and enforcement issues:
 - a. Laws, bylaws and directives do exist and are satisfactorily effectual.
 - b. There are water boards and committees and their role is reasonably effective.
 - c. There are environmental protection societies and groups but their role isn't satisfactorily effective.
 - d. Basin authorities do exist and their role is satisfactorily effective.
 - e. Groundwater directives are available and adequately effective.
6. Water sector data are not easily available. Neither to the public nor to the private sectors. Such data are available at MWI, WAJ, JVA and some research institutes and centres. Such data are considered safely stored and reasonably easy to retrieve. It is seen as being reliable and to a certain extent sufficient for management purposes. It isn't easily available to researchers.
7. The cooperation between decision makers and the research community is weak. However, new technologies addressing emerging challenges are on the whole seen to be easily embraced by the water sector.

8. Generally, the present water administration system does stimulate the implementation of water laws, regulations and policies.

5.4.10. IWRM as a Tool for Climate Change Adaptation in ZRB

Jordan's renewable water resources are currently being exploited at a rate far in excess of the sustainable yield. The Jordan Valley is chronically short of irrigation water, and current freshwater supplies will increasingly be diverted from irrigation to meet the growing demand for municipal and industrial use in the greater Amman area. However, the annual volume of reclaimed water is expected to triple in the next 25 years.

An assessment of the impact of climate change on the water balance of the Zarqa river basin in Jordan has shown that precipitation reduction in the range of 10% to 20% are bound to have significant impact on the total yield of the semi-arid basin (Abdulla et al. 2009). In contrast, the same study has shown that the basin is less sensitive to projected changes in temperature in the range of 1 °C to 3.5 °C.

A 25-year draft Reclaimed Water Utilization Plan has been prepared to support implementation of Jordan's water policies. The draft Plan focused on the Amman-Zarqa Basin (AZB) and was developed in consortium with a Groundwater Management Action Plan for the over-pumped highland's aquifers.

Development of the Plan required open discussion about acceptable use of reclaimed water and the appropriate standards, regulations to safeguard health and the environment, and potential impact on markets for irrigated crops. It required examination of a wide range of interrelated water use and management options from industrial applications and replacing groundwater used for irrigation in the highlands, to replacing freshwater currently used in the Jordan valley for irrigation with reclaimed water.

The key objectives of the Plan are to use reclaimed water, where practical, to exchange for present and future uses of freshwater, and to maximize the returns from the reclaimed water resource. In addition, the plan considered other requirements such as protecting the public, conserving resources (water, soils/land, natural vegetation, etc.), complying with international treaties, and ensuring environmentally sound practices.

Plans for using reclaimed water were best explained and were more readily accepted when “supporting actions” are developed and presented as an integral part of the plans. Supporting actions included: proposals for improved on-farm water management, a regulatory framework, water quality improvement plans, monitoring and information management, and crop marketing plans. Cost effectiveness is important in replacing freshwater with re-used water.

A. Basic Functions for Water Resources Management

The suggested basic functions for water resources management in a river basin are presented in Figure 2, and Table 2 gives a definition of these functions. To illustrate the functions a number of activities have been exemplified for each of the functions. Flood and drought management are not addressed in these materials and have been given separate attention by Cap-Net.

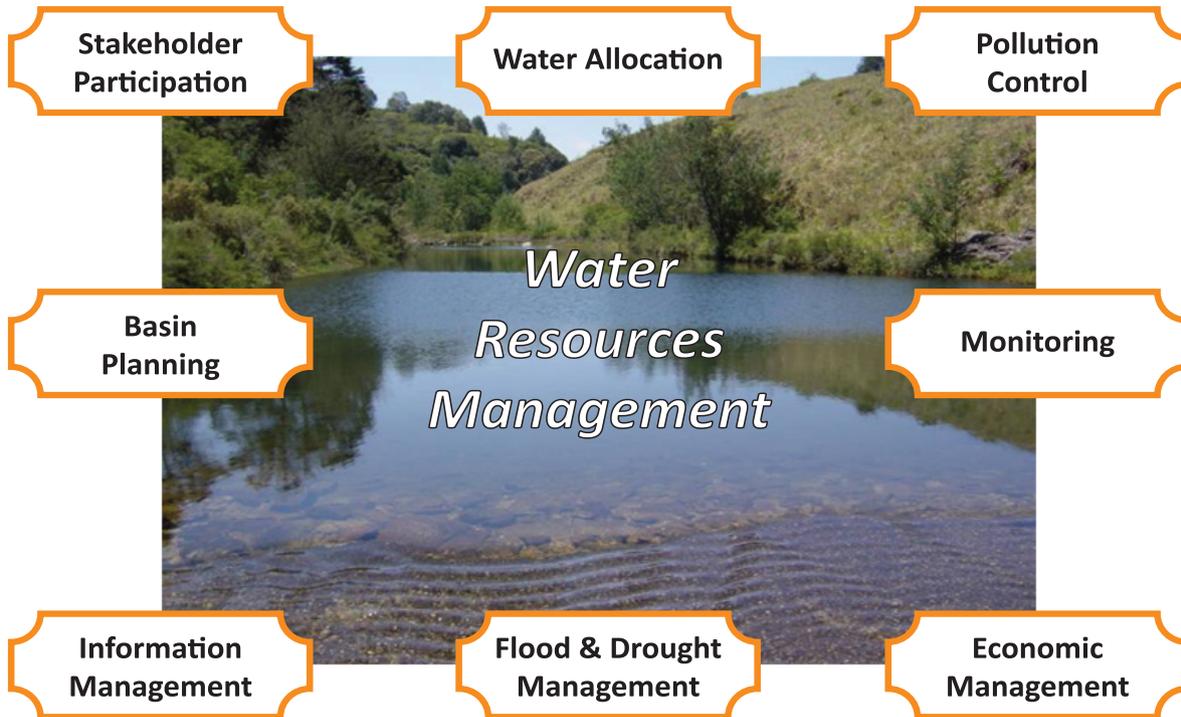


Figure 2: Basic functions for water resources management (based on CAP-NET, 2005)

Table 2: Functions of water resources management in a river basin (based on CAP-NET, 2005)

Function	Example of activities
Stakeholder participation – Implementing stakeholder participation as a basis for decision making that takes into account the best interests of society and the environment in the development and use of water resources in the basin. [Module 4]	<ul style="list-style-type: none"> • Develop and maintain an active stakeholder participation process through regular consultation activities. • Provide specialist advice and technical assistance to local authorities and other stakeholders in IWRM.
Water allocation – Allocating water to major water users and uses, maintaining minimum levels for social and environmental use while addressing equity and development needs of society. [Module 5]	<ul style="list-style-type: none"> • License of water uses including enforcement of these.
Pollution control – Managing pollution using polluter pays principles and appropriate incentives to reduce most important pollution problems and minimise environmental and social impact. [Module 6]	<ul style="list-style-type: none"> • Identify major pollution problems. • License and manage polluters.
Monitoring of water resources, water use and pollution – Implementing effective monitoring systems that provide essential management information and identifying and responding to infringements of laws, regulations and permits. [Module 7]	<ul style="list-style-type: none"> • Carry out hydrological, geographical and socio-economic surveys for the purposes of planning and development of water resources. • Develop, update and maintain a hydrometric database required for controlling compliance of water use allocation.
Information management – Providing essential data necessary to make informed and transparent decisions for development and sustainable management of water resources in the basin. [Module 8]	<ul style="list-style-type: none"> • Define the information outputs that are required by the water managers and different stakeholder groups in a river basin. • Organise, co-ordinate and manage the information management activities so that the water managers and stakeholders get the information they require.
Economic and financial management – Applying economic and financial tools for investment, cost recovery and behavior change to support the goals of equitable access and sustainable benefits to society from water use. [Module 9]	<ul style="list-style-type: none"> • Set fees and charges for water use and pollution.
River basin planning – Preparing and regularly updating the Basin Plan incorporating stakeholder views on development and management priorities for the basin. [Module 10]	<ul style="list-style-type: none"> • Conduct situation analysis with stakeholders. • Assess future developments in the basin.

The water resources management functions comprise a general framework for implementing IWRM for any river basin in the world. For any specific country, region or river basin some of the functions may be more relevant than others. However, for an inhabited river basin with competing water demands all these functions need to be performed to achieve sustainable management of the water resource and to improve livelihoods. In most countries the water resource management functions are guided by the national water laws and policies. Typically these are regulatory functions. Water allocation and pollution control in Table 2 are direct examples of such regulatory functions. The other functions may be partly regulatory but also serves as support for each other. For example, the functions of financial and information management are essential to enable the implementation of all regulatory functions.

B- Institutional Arrangements for Performing the Functions

There is no blue-print for designing an organizational framework to meet the water management objectives and to exercise all the water resources management functions. An important aspect is that there are many institutions as well as water authorities that must be involved in conducting water resources management (Figure 3).

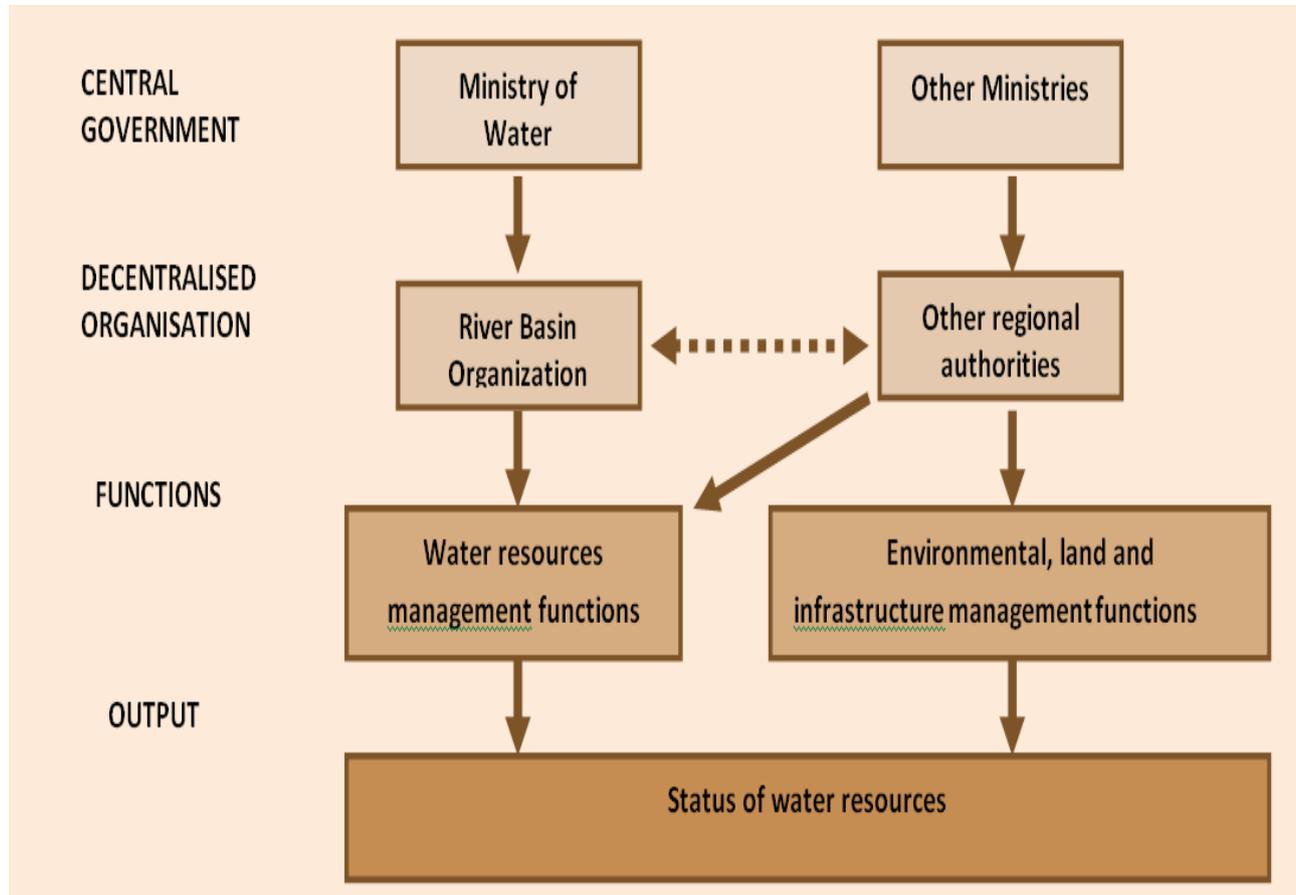


Figure 3: Institutional arrangement for performing water resources management functions

The structure and organizational framework are dependent on the national policies. Normally a river basin organization (RBO) has regulatory functions as discussed in Section 2. Regulatory responsibilities related to the water resources management functions may, however, also be given to other institution than to the regional water authorities. Examples are pollution control that may be the responsibility of the Ministry of Environment or flood and drought management that may be within a general disaster management framework run by Local Government.

For an RBO it is therefore important to avoid dual responsibilities. If other institutions have the regulatory responsibility the RBO should act as a stakeholder and interact with these institutions in the best way possible.

As indicated in Figure 3 there are also related management areas, which directly influence the water resources but which are not part of the basic water resources management functions. An example is land management guiding agricultural fertilizer usage and soil conservation measures, both of which affect quality of the water resources. Also in this case the RBO must act as a strong stakeholder and interact with the relevant ministry or institution.

5.5. Proposed Policy Options For Adaptation on Water Resources in ZRB

One of the first steps in responding to climate change is to identify the policy options available to address the adverse effects of such change. This report will describe a number of government policies that could be implemented in anticipation of climate change to reduce its potential adverse effects. The policy options are considered the water resource and . The anticipatory adaptation options presented here represent the range and type of policies that should be considered; however, the lists are not comprehensive. These lists are meant to provide policy makers with ideas about possible adaptation measures and to stimulate the identification of other adaptation measures.

5.5.1. Criteria for Anticipatory Adaptation Options and Organization Capacity of Policy Lists

All anticipatory adaptation policies should satisfy at least 2 criteria: flexibility and the potential for benefits to exceed costs. The regional impacts of climate change are highly uncertain. For example, Strzepek et al. (1995) found that under some scenarios, the flow of the Nile River could increase by 30%, while under other scenarios, the flow could be reduced by more than half. If adaptation measures only addressed one type of climate change, such as increased flooding due to wetter conditions, they might leave the sector vulnerable to another type of climate change, such as drought

from drier conditions. To address the broad range of uncertainties, anticipatory adaptation policies should be flexible. The objective in selecting an anticipatory adaptation policy should be to enhance the ability to meet stated objectives under a wide range of climatic conditions. As such, a policy may be either robust, meaning it allows the system to continue functioning under a wider range of conditions; or resilient, meaning it allows the system to quickly adapt to changed conditions.

Mitchell et al. (1995) estimate that the most likely rate of average global warming is approximately 0.2°C per decade, a rate at which significant effects of climate change may not be realized for many decades. Similarly, the benefits of anticipatory adaptation policies also may not be realized for many decades. If discounting is used, the net present value of the benefits of anticipating climate change may be low. Thus, only minimal expenditures for adapting to climate change, such as marginal changes in infrastructure and changes in planning, may be economically justified.' In addition to being flexible and having the potential for benefits to be greater than costs, anticipatory adaptation options that meet the following criteria should be implemented now to address climate change.

- Net benefits independent of climate change. Some adaptation options may yield net benefits even if climate change does not occur. Many of these options involve changing plans for responding to particular climate events such as floods or droughts or allowing greater flexibility in response to current climate variability. For example, implementing market based systems for allocating water would result in more efficient allocation of water under the current climate and would allow for a more rapid and efficient response to climate change than would more rigid schemes for water allocation (Frederick & Kneese 1990).
- High priority. Some adaptation options need to be implemented in anticipation of climate change because they would be significantly less or not effective if implemented as reactive policies. Adaptation options that fall into the following sub-categories may be considered high priority:
- Irreversible or catastrophic impacts. These options are policies concerning potentially irreversible or catastrophic impacts of climate change; for example, loss of life or of species, extensive loss of property, or destruction of resources may be irreversible or catastrophic. Such policies warrant consideration because reactive measures will probably be unsuccessful in mitigating the impacts of climate change.

- Long-term decisions. Decisions on many long-term issues, such as the construction of dams, reservoirs, bridges, have long useful lifetimes and may be affected by climate change. Policies affecting the construction of such structures warrant consideration because the initial costs of making the structures less vulnerable to climate change are likely to be significantly less than the costs of adapting the structures after climate changes (NAS 1992).
- Unfavorable trends. Certain trends in growth or resource use may make some types of adaptation more difficult; for example, the fragmentation of habitats is a trend that is unfavorable to wildlife. As climate changes, fragmentation could become an even greater problem as species need to migrate to cooler areas. Policies affecting such trends warrant consideration before climate change, because adaptation may be more difficult in the future or because opportunities to implement low-cost or politically feasible options may be lost (Smith in press).

These anticipatory adaptation options are meant to be useful to all regions of the world. Whether and how these policies are applied in specific regions and countries depends on local circumstances and such matters as whether it is institutionally, culturally, or socially feasible to implement these changes. Thus, the nature of actual adaptation measures may be different in Jordan than in other areas.

5.5.2. Policy Options For Adaptation to Climate Change

The measures in this category can be thought of as broad strategies rather than specific policies. They may be used to complement specific policies addressing problems within a vulnerability sector, such as the examples provided in the policy option lists for each sector.

- Incorporate climate change in long-term planning. Long-term planning for climate-sensitive resources should incorporate changes in conditions that will affect the services provided by those resources. Changes in population and income will affect resource use. So will climate change. Including climate change in long-term plans could result in changes being made that will enhance the ability of future generations to cope with these changes. For example the government of Malawi is identifying possible modifications to projects planned for implementing the National Environmental Action Plan and the National Disaster Action Plan to ensure that climate change considerations are included (Theu et al., in press). This option is high priority because of irreversible or catastrophic impacts.

- Inventory existing practices and decisions used to adapt to different climates. An inventory may focus on actual social and economic decisions in light of variable climatic regimes over time or across regions. For example, agricultural practices in arid and semiarid areas in Jordan,, could be used in areas that may become drier due to climate change. Compilation of information on various practices may be a cost-effective way to identify feasible options for adaptation. In particular, adaptation options that require long-term decisions should be identified and analyzed for implementation (Johda 1989, IPCC 1990; additional research recommendations in Canadian Climate Program 1993, OTA 1993a, b). This option is high priority because of long-term decisions, irreversible or catastrophic impacts, and unfavorable trends.
- Promote awareness of climatic variability and change. Climatic variability and the potential risks of climate change are often not well understood by the public or by decision makers. Because climatic adaptation will affect the individual, organizational, and policy levels, communication about the human significance of climatic variability is important at all levels in a community. Increasing sensitivity to climatic issues will facilitate adoption of measures to prepare for climatic variability and change (Johda 1989, IPCC 1990, Cooper 1992). This option is high priority because of irreversible or catastrophic impacts, long-term decisions, and unfavorable trends. Net benefits are independent of climate change.

5.5.3. Policies for Adaptation With Respect to Surface Water Development

In order to enhance surface water resources in Jordan under new climatic conditions the followings must be implemented in water policy of Jordan:

- Constructing new surface dams and construction of desert dams to collect flood's water occurs during winter season.
- Constructing subsurface storage reservoirs and dams to minimize losses by surface evaporation from existed surface water bodies.
- Protecting surface water supplies from point and non-point pollution sources.
- Reduction of deposition of sediments beyond the construction and mining areas.
- Increase the monitoring systems, management of flash floods and protecting dams and stream flow.
- Introducing new technologies for real time water monitoring to predict the peak flow of streams and rivers, and providing precise knowledge of surface water resources status.
- Conserve water. Reducing demand can increase excess supply, creating a greater margin of

safety for future droughts. Demand for water may be reduced through a range of policies that encourage efficient water use including education, voluntary compliance, pricing policies, legal restrictions on water use, rationing of water, or the imposition of water conservation standards on technologies. Reduced demand will increase current capacity to cope with drought (Canadian Climate Program 1993, OTA 1993a). Net benefits are independent of climate change

5.5.4. Policies for Adaptation With Respect to Groundwater Development

Areas of ZRB are particularly exposed to the impacts of climate change on freshwater resources. That will suffer a decrease in groundwater resources due to climate change impact. The following policies can be introduced to minimize the impact of climate change:

- Introducing metering to control the amount groundwater abstraction.
- Providing alternative water sources for recharge the aquifer through construction of desert dams, treated wastewater recharge and others.
- Importing water from other basins within the country and from neighboring countries.
- Protection groundwater from contamination.
- Substitute by treated wastewater for industrial uses as it will reduce the demand on fresh groundwater resources.
- Developing and utilizing deep groundwater aquifers as large amount of groundwater exists and few studies were done on the deep aquifers.
- Protection of groundwater resources from wastewater through the use of piping for transfer of treated water from wastewater treatment plants and increase of monitoring systems.
- Remediation of all polluted groundwater sources whenever the technology is available.
- Use interbasin transfers. Transfers of water between water basins may result in more efficient water use under current and changed climate. Transfers are often easier to implement than fully operating markets for water allocation. Transfers also can be an effective short-term measure for responding to regional droughts or other problems of water supply (Wahl, 1992; Canadian Climate Program, 1993). Net benefits are independent of climate change

5.5.5. Policies for Adaptation With Respect to Wastewater Development

The wastewater strategy of Jordan 2008-2022 included several policies and action plans concerned with Climate Change impact on wastewater resources in Jordan. It was stated that we should continue to expand the safe use of treated wastewater by building new wastewater treatment plants

and exploring productive uses in agriculture, industry, and urban landscapes. In addition, to explore the potential for using treated wastewater for aquifer recharge as is done in other parts of the world. The overall strategy aimed to achieve Goal 5 that stated treated wastewater effluent is efficiently and cost-effectively used on 2022.

One of Jordan's future challenges is the safe use of treated wastewater for irrigation in the Jordan Valley and its produce will need continuous monitoring and reinforcement. Additionally, drought management and adaptation to climate change will need to be addressed through proper policies and regulations.

In this context, alternative water resources may be defined as water resources that are not readily available and suitable for direct use and will include:

- Reuse of treated wastewater.
- Use of grey water.
- Desalination of brackish water and of seawater

5.5.6. Policies for Adaptation With Respect to Domestic Wastewater Development

The following main challenges will need to be addressed in the future plane under new climatic conditions

- The safe use of treated wastewater in activities that provide the greater return for the economy and society. In irrigated agriculture, a comprehensive risk management system must be established, in order to ensure the health of agricultural labor, the productivity of the soils and hygienically safe produce.
- Control the illegal extraction of treated wastewater downstream of the treatment plants.
- Control the very high BOD rates in the wastewater, which is due to insufficient quantities of water.
- Promote the collection and use of greywater in high-rise buildings through adequate incentive systems.
- Ensure that all major industries have their own wastewater treatment plant.
- Explore decentralized treatment plants for new urban settlements.
- Monitor wastewater and treated wastewater continuously.

5.5.7. Policies for Adaptation With Respect to Industrial Wastewater Development

Industry in Jordan consumes large portion of its fresh water resources, however, most of the industries are located in ZRB. The following policies must be implemented in the national water strategy of Jordan under new climatic conditions:

- Implementation of on-site industrial WWTP
- Reuse of treated wastewater in industry as a substitute for groundwater
- Recycle of treated industrial water
- Reuse of industrial wastewater locally
- Use of brackish industrial water for specific on-site plant programs
- Developing and enforcing laws and regulations regarding industrial wastewater
- Developing of a new Industrial Waste Water Treatment Plants (IWWTP)
- Implementation of an industrial wastewater discharge fee system
- Implementation of an industrial waste minimization program
- Implementation of a central toxic and hazardous waste handling and treatment facility
- Emergency handling and containment facilities for industrial waste dischargers

5.5.8. Policies for Adaptation With Respect to Irrigation management Development

Irrigation consumes more than 64% of the water resources in Jordan. Good management of irrigation water can save huge amount of Jordan's scarce water resources especially under higher temperature due to new climatic conditions. This can be achieved through implementation of the following policies.

- Use of drought-tolerant and salt-resistant crops
- Upgrading irrigation infrastructure
- Use of water-efficient technology
- Conservation and restoration of ecosystems
- Engaging in water trade, in either the temporary or permanent market.
- Reduce production
- Construction of small on-farm reservoirs
- Implement water harvesting techniques at farm level
- Improve farm management practices

5.5.9. Policies for Adaptation With Respect to Greywater

The greywater use was mentioned in the Jordan's Water Strategy 2008-2022 as future challenges

and need to be addressed. It was stated that to promote the collection and use of grey water in high-rise buildings through adequate incentive systems for internal and non-drinking purposes. The use of greywater will be encouraged in areas not yet connected to the sewer.

Here, it can be suggested that utilization of grey water in not only in the areas that are not yet connected to the sewer system but also:

1. Large Water Consumers such as Hotels, industrial, complexes and others.
2. National Standards for Grey water quality and utilization technologies should be set.
3. Also, utilization of Grey water in vulnerable communities located within the ZRB could decrease the load on wastewater treatment plants and manage water demand on household level.

5.5.10. Policies for Adaptation With Respect to Desalination Development (Brackish Water)

Several brackish springs have been identified in various parts of the country. Estimates of stored volumes of brackish groundwater for the major aquifers suggest immense resources, but not all of these quantities will be feasible for utilization. In context of Climate Change will likely have its most pronounced effects on brackish and freshwater marshes in the coastal zone through alteration of hydrological regimes? However, Jordan will witness a rise in temperature, drop in rainfall resulting in reduced water availability and stream water flow at ZRB, brackish water can be formed due to overexploitation of groundwater, decline of groundwater level, and lack of recharge resources. In addition to brackish water that can be produced from industrial and agricultural activities.

The Goals for Alternative Water Resources by 2022 can be achieved by establishment of sufficient infrastructure for desalination of brackish water. The water supply strategy mentioned in Goals 2 and 4 that a program to desalinate brackish waters on a short, medium and long-term basis will be set. The potential of brackish water resources will be assessed in terms of sound technical, economic and environmental feasibility in all groundwater basins within the Kingdom, and then conduct research and studies on desalination and on optimization of brackish water use in agriculture and industry. Brackish water resources will be allocated, either desalinated or in their natural condition, to their best uses in order to provide additional water supply. When desalinated they can produce additional water for municipal, industrial and commercial consumption.

In Goal 2 encouragement of the international cooperation will be continued for the promotion of research, development, information exchange, and training in the field of desalination and other non-conventional sources. Therefore, technology transfer and advanced research in desalination engineering shall be introduced.

The strategy approach to achieve the Goals particularly Goals 2 and 4 for alternative water resources by 2022 is based on establishment of a program to desalinate brackish and sea waters on a short, medium and long-term basis

5.5.11.Policies for Adaptation With Respect to Virtual Water Resources Development

The amount of water required to produce food changes according to the crops, varies from place to place, and depends on local productivity and conditions of available water supply through rainfall or irrigation. Water consumed in the production process of an agricultural product is known as ‘virtual water’. Climate change scenarios for Jordan are all predict a further decline of our water resources, that is mean virtual water should be considered to conserve our water resources which two third of them already used for irrigation.

The virtual water was mentioned implicitly within the context of Jordan’s Water Strategy for 2008-2022. For example on control of regulation and water pricing the government will discourage planting crops with high water requirements through the use of market pressures by imposing higher water tariffs on irrigated agriculture.

Jordan must remove tariffs on imported crops to promote transition to crops with higher economic returns per unit of water used. For instance, growing bananas is a commonly cited but not unique example of an egregious waste of water to produce a crop that can be imported significantly cheaper than it can be produced in Jordan. Jordan can no longer afford such uneconomical use of scarce water supplies. Therefore, policies related to:

1. Regulation Control on water use
2. New crops pattern
3. Importing crops with high virtual water value
4. Pricing policy

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For more information
United Nations Development Programme
United Nations Building
Queen Rania Street
Building No. 274
Jordan
Email: registry.jo@undp.org.
Website: www.undp-jordan.org

