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Environmental Security

Integrated Water Resources Management and Security in the Middle East

Edited by
Clive Lipchin
Eric Pallant
Danielle Saranga
Allyson Amster

Springer

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Integrated Water Resources Management and Security in the Middle East

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Series C: Environmental Security

Integrated Water Resources Management and Security in the Middle East

edited by

Clive Lipchin
Arava Institute for Environmental Studies
Israel

Eric Pallant
Allegheny College, Meadville
PA, U.S.A.

Danielle Saranga
Arava Institute for Environmental Studies
Israel

and

Allyson Amster
Arava Institute for Environmental Studies
Israel

Springer

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INTRODUCTION

ERIC PALLANT[1], CLIVE LIPCHIN[2*], AND MARISSA T. ISAAK[2]
[1]*Department of Environmental Studies, Allegheny College, Meadville, PA, USA*
[2]*Arava Institute for Environmental Studies, D.N. Hevel Eilot 88840, Israel*

While warfare has become nearly synonymous with the Middle East, remarkably no war has erupted over water. Not yet. Water resources are in scarce supply in the Middle East and demand is growing. Nevertheless, water supplies have been cut off during conflicts and, at other times, have led countries to the brink of war (Glieck, 2004). Environmental security, however, requires more than just freedom from military attack. It also means access to high quality water, in sufficient quantities, to ensure public health, the production of sufficient food stocks, and the potential for economic development. High quality water is in desperately short supply in the Middle East: every country in the region supplies less water per capita than the United Nations suggests is an appropriate minimum for human consumption (Falkenmark et al., 1989). Regional as well as domestic security hinges on water management and water shortages will undoubtedly be one of the defining environmental security issues of the 21st century (Pearce, 2006).

This book investigates water security at every level: domestic, national, and international. While its focus is the Middle East – and with good reason, it is militarily volatile, climatologically unstable, and operating with an annual, regional water deficit – case studies elucidated here are being repeated around the world. Thus, this book provides analysis that others around the globe will surely find helpful. Moreover, almost all of the chapters mention the impact climate change will have on water management and security. In this regard, too, analysis of the impact of climate change on water security will make this book useful to practitioners in other parts of the world.

The highest per capita water withdrawals in the world occur in the Middle East and North Africa (MENA), where irrigated agriculture is a main water user (Stockholm World Water Week, 2006), and rainfall is low and unreliable. The prognosis for meeting the demands for agriculture in the next 50 years will require at the very least "thinking differently about water" (Stockholm World Water Week, 2006).

*Tel: 972 528 964992, Fax: 972 8 6356634, E-mail: clive@arava.org

C. Lipchin et al. (eds.), Integrated Water Resources Management and Security in the Middle East, vii–xii.

The countries of the Middle East – Israel, Jordan, the Palestinian Authority, Egypt, and parts of Lebanon and Syria – must all contend with growing populations and unpredictable water supplies. Rainfall varies from north to south (more in the north), with elevation (more on high western slopes), seasonally (the Mediterranean climate provides precipitation almost exclusively during the winter months), and most challengingly, from year to year. This last has been true since biblical times when Joseph was the last person to accurately predict 7 years of rainfall followed by 7 years of drought. Since then, interannual variation has been a largely unpredictable fact of nature. Consequently, the countries of the Middle East are heavily reliant on extracted groundwater and highly managed surface water. Nearly all of this is being used more rapidly than the rate of recharge.

Probably the most striking example of water insecurity occurs in the Gaza Strip, where both water shortages and extensive contamination of drinking water affect nearly all its inhabitants (Bohannon, 2006). Palestinian aspirations for economic development are further hampered in the West Bank where agriculture has been particularly stymied by water scarcity (Faten and Isaac, 2001).

Jordan's water woes are primarily a function of water shortages. During the droughts of the late 1990s, the average Jordanian lived with year-round rationing: a daily per capita allotment of just 88 L/day (US Water News, 1998, 2002). To this day, Jordanians receive running water only 1 day a week, a decline in water consumption of 94% compared to the 1940s (US Water News, 2002).

Israel fares better than both Jordan and its Palestinian neighbors, but present supplies still allow Israelis to consume only 50% of the annual per capita absolute scarcity level of 500 m^3 (Falkenmark et al., 1989; Tal, 2006). Israel has achieved its relative abundance through a variety of water harvesting techniques, technological advances in irrigation and water reuse, and desalination (Lonergan and Brooks, 1994; Tal, 2006). Nevertheless, Israel continues to consume groundwater from its two main aquifers and from Lake Kinneret (Sea of Galilee) at unsustainable rates.

The intersection of politics, economics, and military might are especially acute in the Middle East. Israel maintains control over access to water resources crucial to economic development in the Palestinian Authority, limiting Palestinian access to groundwater. This inequity in water distribution restricts agricultural and Industrial development in the Palestinian Authority. The average Israeli consumes four times as much water as the average Palestinian (B'Tselem, 2006). The question of water equality is not as simple as we have described it here. Cultural and historical narratives shape perception. Different nationalities often look at the same water resource and perceive different data (Fischer, 2005; Isaac et al., 2005; Kubursi, 2005; Lipchin et al., 2005).

Israel also uses its comparative wealth to increase supplies of water, e.g. desalination and advanced water reuse, in ways that Jordan cannot afford. Thus, wealth supplies options in water security for growing populations that are not available to poorer countries. There is a cost to the environment, however. Expanding water supplies in Israel has led to depleted rivers and sinking water tables at great expense to plants and wildlife.

Further confounding the challenges of developing water security in the Middle East is the large proportion of transboundary water bodies, both surface streams and groundwater. Nearly all the countries of the Middle East share riparian access or drill into the same groundwater sources as a neighboring country; few are sole proprietors of sufficient water. Thus, international cooperation or conflicts are a necessity. For example, Syria, Lebanon, the Palestinian Territories, Jordan, and Israel all extract water that once flowed to the Dead Sea. A later chapter in this book demonstrates how lack of regional water management plans has led to overextraction and is threatening the Dead Sea and its ecosystem.

While the rapidly declining level of the Dead Sea is probably the most visible manifestation of the impact of several nations extracting freshwater resources, it is not the only one. The Jordan River and the Mountain Aquifer beneath the West Bank are both severely overdrawn and contaminated by more than one nationality (Tagar et al., 2004; Bromberg, 2005; Tagar and Qumsieh, 2006). Again, water management and security is not limited to the Middle East. Representatives of the many countries attending this Advanced Study Institute (ASI) made it quite clear that the Middle East is the only one location of many around the globe where transnational water conflicts are significant.

This brings us to the explanation for this ASI and subsequent book. We thought it was essential to bring together regional and global experts to discuss the related issues of water security and integrated water resources management. We selected Israel because it is a centrally located hotspot: militarily, hydrologically, geographically, and politically. The book opens with a discussion of environmental security narratives that have evolved in relation to the water resources of the Middle East. Stuart Schoenfeld of York University and coauthors discuss the development of narratives in response to the declining Dead Sea and the importance of such narratives in developing cooperative mechanisms for integrated water resources management.

This book is one of the first volumes to encompass scholarly material from Israelis, Palestinians, and Jordanians alongside nonregional participants on the water issue in the Middle East. The book is organized to highlight case studies of specific national and local hotspots as well as presenting frameworks for thinking about resources and security more generally. To that effect, the book begins with the first section on “Water Resources in the Middle East.” This section contains four chapters, the first of which takes a holistic angle analyzing MENA freshwater resources, and arguing that the classical supply side solutions may not solve the region’s water shortages. David Brooks, working with Friends of the Earth Canada, contends that new institutions are needed to execute demand management scenarios for the entire region. The following three chapters in the section take national approaches to the problem of water and security presenting the Israeli, Jordanian, and Palestinian perspectives. These articles expose the national interests indigenous to the geography of each of the countries and posit potential solutions. For Israel, Sinaia Netanyahu, of Tahal Engineering, Inc., describes the advantages and challenges associated with being the most industrialized country in the region. Within the Jordanian context, Samir Talozi lends insider perspectives on the unique Jordanian landscape maintaining a development-centered strategy for future water management. Alice Gray and Jane Hilal of the Applied Research Institute, explains the problematic context complicated by sovereignty issues in which Palestinians must navigate their own freshwater dilemmas. This section reveals both points of potential conflict between the national interests and points of agreement. It highlights the centrality of water policymaking and security for these three national entities.

The second section, “Policy and Management Options,” gives a diverse set of lenses through which water security can be viewed. Hans Gunter Brauch, of the Free University of Berlin, offers a conceptualization of environmental security broadly at the global level and narrowly at the level of the Middle East. Ursula Oswald, from the National University of Mexico, filters the discussion through the climate change kaleidoscope offering a hydrodiplomacy model for supranational cooperation. The two papers, taken together, offer a comprehensive insight into the nexus among environmental security, climate change, and water resources management. The next paper, offered by Paul Jeffrey of Cranfield University, United Kingdom, focuses on technological alternatives for increasing water supplies. By linking the Middle East with the European experience, he demonstrates the value of this type of interregional analysis. This paper is followed by an analysis from Alon Tal of Ben Gurion University of the Negev, who furthers the assertion that different regions can benefit from an international viewpoint. His work looks at the international legal dimension concluding that the legal sphere can be an excellent method in which to ensure both proper quality and quantity of water resources, and also to protect environmentally significant ecological habitats. These two papers, point to a modern technocratic perspective that rely heavily on the work of experts.

The next paper, by Eva Rathgeber of the University of Ottawa and Pnina Motzafi-Haller of the Ben Gurion University of the Negev, incorporates a gender-centric analysis into the topic of water security. This gender-sensitive approach, currently underutilized in the Middle East, would recognize public vs. domestic water use and the distinct roles each gender plays relative to water resources and their management.

The final two chapters of the section examine first the impact of Zionist ideology on policy in Israel and then the possibility of creating an international water trading market. The two articles, while dealing with different concepts, both begin from a point of ideology, the first Zionism, and the second market-based conservation, and explain how the concepts have shaped the past and may impact the future. Clive Lipchin, of the Arava Institute for Environmental Studies, recommends a rethinking of Zionism that tempers the need of agriculture supplanted by ecological considerations. Joy Braunstein, of the University of Pittsburgh, in analyzing the suitability of water resources to be traded as an international commodity, acknowledges that extreme stances toward market-based approaches contain serious pitfalls and tasks policymakers to find new solutions that solve for the identified problems.

Finally, the book concludes with a series of case studies that take many of the proposed theoretical propositions and analyze their efficacy when implemented. Lior Assaf of the Arava Institute for Environmental Studies and coauthors, examine transboundary rivers and streams in Israel/Palestine making clear that the existing lack of cooperation between the parties leads to polluted resources. Their model of cross boundary cooperation posits an ecosystem and watershed approach to surface water management. An approach that is common in many parts of the world but sadly has yet to be fully implemented in the Middle East.

Rudi Orthofer of ARC Systems Research, together with coauthors, addresses one of the most visible opportunities for transboundary cooperation: the Dead Sea. His research analyzes scenarios for long-term rehabilitation of the Dead Sea, pointing out the multitude of variables that will impact such a recovery.

Robin Twite of the Israel Palestine Center for Research and Information discusses the important role that the nongovernmental organization (NGO) community plays in managing scarce and shared water resources in the Middle East. He documents the unique approach that NGOs can offer to integrated water resources management in the region.

Finally, Clive Lipchin and Eric Pallant, the directors of the ASI, would like to thank the many people who assisted in the planning and running of the ASI and the production of this book. We are especially indebted to Danielle Saranga, Sara Holzman, and Marissa Isaak for the dedicated hard work in making the ASI the success it was and to providing the attention to detail editing for this book. We are also especially grateful to Abby Lutman of the Arava Institute for Environmental Studies for her assistance in the editing process. We are also exceedingly thankful for the help, cooperation, and support of the staff and faculty of the Arava Institute for Environmental Studies and to the residents of Kibbutz Ketura for opening up their homes to the participants.

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RETELLING THE STORY OF WATER IN THE MIDDLE EAST: REFLECTIONS ON AND ABOUT A CONVERSATION AT THE DEAD SEA

STUART SCHOENFELD[1*], ERIC ABITBOL[2], AND FRANCESCA DE CHÂTEL[3]

[1]*York University, 210 Robert Street, Toronto, Ontario, Canada*
[2]*Concordia University – Peacemedia-Paixmédia, Montreal, Canada*
[3]*Freelance writer and editor*

Abstract: Water planning for Israel, the Palestinian Authority, and Jordan has been strongly influenced by the narrative of development. The word "development" implies a narrative about how the less prosperous parts of the world can become more like the prosperous ones by producing goods and services for the world market, typically by using powerful technologies and exploiting natural resources. Development is usually a story of nation-building, but sometimes it also becomes a narrative about fostering regional cooperation. However, the narrative of "development" is not the only way to understand the relationship between the prosperous parts of the world and the less prosperous ones. Another story, sometimes referred to as the "post-development" narrative, emphasizes a past of unequal relations between countries and economies, and continuing inequalities. This narrative is also sensitive to the emergence of environmental degradation and a world environmental crisis. The lessons to be learned from this story are of the necessity for social and political cooperation rooted in a respect for ecosystem realities and natural limits. In contrast to "development," the key phrases of this story are "adaptation to nature" and seeing the benefits and assuming the real challenges of "letting nature take its course." This emerging "post-development" narrative suggests another approach to water planning and is used to examine the problems of the Dead Sea. The diversion of water resources for national development strategies is turning the area around the Dead Sea into a "sacrifice zone" where agricultural and tourist communities alike are at risk and the sea is shrinking dramatically. The

*To whom correspondence should be addressed. Prof. Stuart Schoenfeld, Sociology, York University, 2275 Bayview Ave, Toronto, Ontario M4N 3M6 Canada; e-mail: schoenfe@yorku.ca

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regional development solution of a multiple billion dollar Red Sea–Dead Sea "Peace Conduit" could vastly increase the water supply in the region and raise the level of the sea, but the conduit would not address the related degradation of the Jordan River, and the project carries new risks to the water composition of the sea, the ecology of the Arava valley through which it would pass, and the Red Sea area of Aqaba/Eilat. The "post-development" critique of the development narrative suggests, instead, adapting to nature and letting nature take its course by exploring strategies for restoration of the Jordan River – Dead Sea watershed.

Keywords: Dead Sea; water; Israel; Palestinian Authority; Jordan; World Bank; Peace Conduit; sacrifice zone; narrative; development; regional development; post-development

1. Introduction: An Evening by the Sea

It had been a long day when we regrouped in the large classroom at the Ein Gedi Nature Reserve's Field School on the western shore of the Dead Sea. Our group of engineers, scientists, social scientists, and environmentalists had visited the Dead Sea works, seen at close range the retreat of the Dead Sea shoreline, examined sinkholes from up close, and explored the area in small groups. Some of us had swum in the sea, covering ourselves in its renowned mineral mud. Others had walked through the small green strip that flows from the David Spring toward the Dead Sea, gazing at ibex and hyrax. A few walked around the date palm groves of Kibbutz Ein Gedi, where trees tilted into sinkholes and access roads had been closed. For some, it was their first visit to the Dead Sea; others had been there many times.

A week before, our group of sixty had been brought together to explore possible meanings and implications of "Integrated Water Resources Management and Security in the Middle East" under the auspices of a NATO Advanced Study Institute (ASI) at the Arava Institute for Environmental Studies (AIES) on Kibbutz Ketura in Israel. We had been challenged to think about the changing meaning of "security" with respect to water in this conflict region. Professor Fernando Carvalho Rodrigues, the programme director for Threats and Challenges of the NATO Public Diplomacy Division in Brussels, opened the ASI introducing recent thinking about security, a theme which was further elaborated by two of our participants, Hans Günther Brauch and Ursula Oswald (2006).

Rodrigues, Brauch, and Oswald outlined shifting perspectives on the notion of security, a shift from a narrow military security approach to one that incorporates human and environmental security. The shift in diplomatic language, which adds a concern for human security to the traditional language of national security, is an important one. The human security agenda promotes the view that the security of people is as legitimate an object of international relations as the security of states, and that the security of states is now understood as contingent upon the security of people and communities. Human security concerns draw the international community into responding to humanitarian crises and protecting human rights.[1] This shift has influenced the way policymakers also talk about environmental security, itself a relatively new term. If originally the concern for environmental security was how environmental issues affect the security of states, more recently under the influence of human security discourse, that agenda has been broadened to include defending the environmental rights of people and communities.

Having framed the discourse together, our group got down to work. We listened to expert lectures in various disciplines and were learning from each other through seminar dialogues, field visits, and informal exchanges. We discussed water scarcity, the various ways in which water is collected and used, proposals to increase the regional water supply, and how to amplify the efficiency of every drop of water.[2] We learned how problematic water issues are in the region, how some communities were reaping abundant harvests while others were visibly, painfully thirsty. We were seeing how the issues around the management of the Dead Sea were symptomatic of broader, regional problems.

One week into the NATO ASI, we found ourselves in a seminar room at Kibbutz Ein Gedi. The high-profile panel that came to share their perspectives with us on that February evening, chaired by Gidon Bromberg, the Israeli Director of Friends of the Earth Middle East (FOEME), did not expect passive listeners, and we did not disappoint. Ittai Gavrieli, from the Geological Survey of Israel, presented a detailed overview of the geological history and current problems of the Dead Sea. The shrinkage of the sea since the 1960s has primarily been due to upstream diversion of water from the Sea of Galilee and

[1]See further the human security gateway maintained by the Canadian government (http://www.humansecuritygateway.info/), the Human Security Unit of the United Nations (http://ochaonline.un.org/webpage.asp?Page=1516), and the Human Security Centre at University of British Columbia (http://www.humansecuritycentre.org).

[2]This draws on a phrase from a presentation by Elias Salameh (2004), professor of Hydrogeology and Hydrogeochemistry, University of Jordan, at the University of Amman on the possibility of redefining the water poverty index (WPI) to reflect more precisely the ways in which water is used, consumed, recycled, and disposed.

the Yarmuk River for agricultural and domestic use. It is further damaged by mineral extraction at evaporation ponds, which effectively make up the southern basin of the Dead Sea, maintained by the Israeli and Jordanian chemical works (Gavrieli, 2006).

Without significant human, ecologically sound political intervention, it is believed the Dead Sea will continue to evaporate, between 100 and 130 m below its current level, at which point it should even off again, becoming a small but stable body of high salinity water, maintained and replenished by underground springs. The Dead Sea is already at its lowest level in recorded history (–417 m below sea level) and is declining at a rate of 1 m/year. If this situation were to continue, more mudflats would be exposed, hundreds of meters from even the current, withdrawn shoreline. Safety problems associated with sinkholes would become more severe, with shorelines collapsing in perhaps unpredictable ways.[3]

That evening, Galit Cohen, representative of the Israeli Ministry of the Environment, explained that the continued shrinking of the sea and the instability of the surrounding ground had led 5 years ago to canceling proposed tourism projects in Israel. The Israeli government was acknowledging the crisis of the Dead Sea, while noting the need to respond to various ecological, economic, and political interests and concerns (Cohen, 2006). An Israeli inter-ministerial committee has been convened and was until recently very active in studying the consequences of present trends, aiming to develop a plan to address the crisis and, as was noted that evening, perhaps even accept that people in the region will have to learn to live with the ongoing deterioration.[4]

Dov Litvinoff, mayor of the Tamar regional municipality and third panelist that evening, explained the local impact. With deterioration of the area surrounding the Dead Sea, the future economy of the region is endangered. Despite the small size of the local population, plans for development are on hold because it is impossible to build or even find investors. The roads are in danger of becoming more unstable, and insurance is difficult to secure. Local plans for new initiatives to create jobs and bring more people to live in the region have mostly been shelved. It is a dire situation, and Israelis, particularly those in the immediate region, are deeply concerned about the future of their communities, livelihoods, and hopes for a good life (Litvinoff, 2006).

[3]The term “sinkholes” refers to specific areas of land subsidence in the form of holes in the ground which range from a few centimeters to tens of meters both across and in depth. It is only very recently that scientists have begun to understand the sinkhole phenomenon and the patterns of their appearance.

[4]See Gavrieli and Bein (2004) for a technical report that discusses the policy options under consideration by the Israeli government.

The various panel presentations were clear and concise. Then a very active and sometimes heated question and answer session began. The evening went on for another hour and a half. The following summary of questions gives an idea of how participants at the NATO ASI probed and challenged what we had heard:

> Why don't planners talk about the declining Dead Sea in the context of the regional water system – the Sea of Galilee, the Jordan River, the aquifers, transboundary surface waters, the Red Sea, the Mediterranean, plans for desalination, and the continuing high demand on water for consumption, agriculture, tourism, resource extraction, and industry?
>
> How can Israel unilaterally develop any kind of plan for the Dead Sea given that other stakeholders include, at the very least, Jordan and the Palestinian Authority?
>
> How can national and local plans for the area call for massive increases in population growth and tourism when these are likely to further deplete the local water table, putting unwelcome pressure on an already unstable system?
>
> Since some World Bank financed mega-projects have compounded rather than solved problems, shouldn't the Red-Dead Canal project be approached very cautiously, with *numerous other alternatives* explored first?
>
> Finally, has the Israeli government abandoned its own leadership and commitment to "sustainable development" with respect to water, the Jordan River system, and the Dead Sea?[5]

There were no explicit answers to these questions that night, and probably many of them went beyond what members of the panel were prepared or authorized to address. Yet the questions raised were important ones.

In this paper, we explore why these questions are so difficult. The future of the Dead Sea is one dimension of the future of the ecological region of which it is a part, stretching up through the Jordan River and the Sea of Galilee to the

[5] At the 2002 World Summit on Sustainable Development in Johannesburg, Israel declared its commitment to "sustainable development." The Israeli government has committed itself to incorporating the concept and its ideals into the work and practices of Israel's various ministries. See the Ministry of Foreign Affairs website: http://www.mfa.gov.il/MFA/MFAArchive/2000_2009/2004/10/Stepping%20toward%20Sustainable%20Development%20-%20Oct%202004 and also the website of the Ministry of the Environment: http://sviva.gov.il/Enviroment/bin/en.jsp?enPage=bulletin&enDisplay=view&enDispWhat=Zone&enDispWho=october_bull04&enZone=october_bull04&p=bulletin.

river's headwaters in Israel, Jordan, and the Golan Heights. Israeli and Jordanian development policies have considered this broader watershed a uniquely valuable resource for national development, and Palestinians naturally have a claim on it as a resource for their development as well. The upstream watershed is one of the region's major sources of freshwater, while the southern end of the sea has been developed as a major world source of fertilizers and other valuable chemicals. The Dead Sea area itself has been treated, without formal acknowledgment, as an "ecological sacrifice zone" (Fox, 1999), a landscape that is being destroyed because that destruction is perceived to provide greater value than its preservation or alternate use.

In the sections that follow, we review how the problems of the Dead Sea became so controversial and critical, and we show that there is more than one way of thinking about the regional ecology of which the Dead Sea is a part. Contemporary ideas about "development" are not the only choice. The word "development" is part of a narrative about how the less prosperous parts of the world can become more like the prosperous ones by producing goods and services for the world market, typically by using powerful technologies and exploiting natural resources. Development is usually part of the story of nation-building but sometimes it also becomes a narrative about fostering regional cooperation. However, the narrative of "development" is not the only way to understand the relationship between the prosperous parts of the world and the less prosperous ones. Another story, sometimes referred to as the "post-development" narrative, emphasizes a past of unequal relations between countries and economies, and continuing inequalities. This narrative is also sensitive to the emergence of environmental degradation and a world environmental crisis. The lessons to be learned from this story are about the necessity for social and political cooperation rooted in a respect for ecosystem realities, and natural limits. In contrast to "development", the key phrases of this story are "adaptation to nature" and seeing the benefits and assuming the real challenges of "letting nature take its course."

In exploring this contrast between "development" and "letting nature take its course," we are not making a utopian or an antitechnology or a Luddite argument. We too value good tools. The question is – how do we use them? What are the values guiding their use? As someone pithily said, "Just because you can, doesn't mean you should."

2. The Emergence of Controversy over the Dead Sea

In the late 1990s, as the Dead Sea retreated and sinkholes first appeared noticeably on the western shores (both in the occupied West Bank and in Israel), a geologist living at Ein Gedi, Eli Raz, attempted to bring the severity of the issue to the attention of Israel's government. He was first ignored, then encouraged to keep such worries to himself out of concern that international tourism might be frightened away and that additional international attention might turn to the issue in scientific, economic, and political circles (Raz, 2003). Of course, an environmental crisis of this magnitude in the Holy Land would not remain out of sight for long.

In the first years of the 21st century the Israeli government created a multi-sectoral steering committee to plan a strategy responding to the crisis of the declining Dead Sea and the imminent water crisis in the region. It is important to remember that we are talking about a region where economic and environmental policies always have implications for unresolved disputes, military confrontations, and tenuous peace agreements.

The Steering Committee was composed of representatives from the various concerned ministries: environment, national infrastructure, tourism, and others. The geological survey of Israel was represented, as was Eli Raz. Gidon Bromberg of FOEME was an observer, consulted on transboundary, multistakeholder management of the region's water resources. The Committee's deliberations produced a strategy to conduct three studies, weigh options, and act based on their findings

The first study would involve a scenario where nothing was done to respond to the declining Dead Sea. Studies have projected that the Dead Sea will continue to decline for another 100–150 years or so and stabilize again at some –687 m of depth, remaining the lowest point on the earth's surface (Bein, 2003). The Jordan River would continue to be little more than a sewage canal during hot summer months, despite being a beautiful river at the top of its journey from the Golan Heights to the Sea of Galilee. According to this option, Israel would likely satisfy its growing water demand by constructing a series of desalination plants along its Mediterranean coast. This scenario now appears to serve as the de facto baseline to other possibilities.

Another option, announced by Israel and Jordan in 2002 during the Johannesburg World Summit on Sustainable Development (Gavrieli and Bein, 2004) and under consideration for funding from the World Bank, is the construction of the Red Sea–Dead Sea Canal (RSDSC; also known as the Red–Dead Canal or Red–Dead Conduit) or "Peace Conduit" to go from the Red Sea northward through the Arava valley to the Dead Sea. The proposal to construct the Red–Dead Canal, first made in 1855 (Gavrieli and Bein, 2004), would replenish the Dead Sea at a rate of about 650 MCM (some say as much as 750 MCM) of water annually. It would also take advantage of the drop in elevation to generate hydropower, and use that energy to desalinate water for drinking for Amman and other thirsty communities. Currently, the Jordanian capital, whose population has grown rapidly, experiences severe water shortages in summer, often receiving less than 2 days of water weekly.

In July 2005, the World Bank announced that it brought together representations of Jordan, Israel, and the Palestinian Authority with donor representatives from Europe, Japan, and the USA to raise the funds for the RSDSC feasibility study (UNISPAL, 2005). In April 2006, the French Development Agency approved a €2 million grant toward the Red Sea–Dead Sea Water Conveyance Project feasibility study. Previously, the French Global Environment Fund had agreed to a €1 million grant for the same purpose (*Jordan Times*, April 9, 2006). In June 2006, the Israeli National Infrastructures Minister, Binyamin Ben-Eliezer, and Jordan's Minister of Water and Irrigation, Mohamad Zafer al Alem, agreed to submit a joint request to the World Bank to begin the feasibility study (Kennemer, 2006).

Reviews of the RSDSC proposal note potential negative environmental effects for consideration in the feasibility study. The changed water composition in the Dead Sea could produce gypsum precipitate and algae and bacterial blooms, with implications for appearance of the Sea and for the operations of the chemical factories at the southern end. Aquifers throughout the Arava, upon which numerous kibbutzim and industries depend, may become subject to salination from conduit leakage. Additionally, pumping out large volumes of water could damage the ecology of the Red Sea (Benveniste, 2004; Gavrielli and Bein, 2004).

The final option to save the Dead Sea is perhaps a deeper, more "natural," even simpler one, which would entail "letting nature take its course" – letting the Jordan River flow again, responding to the region's water crisis using a range of diverse, alternate approaches based on this simple premise. What would need to happen throughout Israel, Jordan, the Palestinian Authority, and perhaps elsewhere in the region – politically, scientifically, economically, culturally – to allow for the range of human and ecological needs to be met, based on the premise of letting the River Jordan flow again? The Israeli government committee has already acknowledged that it would explore this question as one possible strategy in an effort to save the Dead Sea. However, for the time being, as our colleague from the Ministry of the Environment confirmed in February 2006, the Israeli government had not assigned resources for such research.

Implicit in this controversy over the "Dying Dead Sea" and what to do about it is a debate between two narratives about the human–nature relationship. On the one hand is a story of the increased ability of humanity to manipulate nature, to provide a historically unprecedented level of mass prosperity in countries which have come to be "developed," which can then be spread to "underdeveloped" countries. On the other hand is a story which begins as an alternate view of development, noting its risks and failures, and questioning its long-term validity as a guide to an unfolding future. This story forecasts an "unhappy ending" to humanity's attempts to dominate nature. It suggests that humans have the ability to change by learning to adapt to nature rather than dominate it and, within that adaptation, to intervene as lightly as possible and let nature take its course – i.e. to respect the complex natural processes of the ecosystems that sustain us.

In the sections that follow we unpack these narratives and consider their implications for Israeli, Jordanian, and Palestinian water policy.

3. The Narrative of National Development

The panel on the Dead Sea at Ein Gedi took for granted the goal of national development. What could be more natural for a government scientist, a civil servant, and a mayor? Governments are in the business of improving the lives of their peoples. The nation-state's land contains resources. The question about resource utilization is not "whether" to use resources, but "how." As the panel made clear, from the perspective of national development, agricultural productivity, tourism development, and chemical extraction are all valid uses of national resources. From this perspective, problems arise when activities that promote one kind of development interfere with another, or when the pursuit of one national agenda undermines the agendas of others who draw on the same resources.

Here, no one proposed a difference between an Israeli, Jordanian, or Palestinian outlook, although all panelists were Israeli. National narratives are about self-determination, self-sufficiency, and protection from external "Others."[6] Representatives of other governments in the region might have used different rhetoric and examples, but the underlying assumptions about national development would likely have been the same.

In modern times, the goal of national development is part of the narrative of the conquest of nature, a story about how we perceive nature and are able and willing to bend it to our will. These days, few people will explicitly admit to believing in the conquest of nature, yet much of our daily routine and the economic planning of our governments take this for granted. Back in the early days of modernity, when the human population was much smaller and the storehouse of nature's treasures seemed almost beyond measure, our scientists, economists, and politicians were full of optimism, plans, and promise. We could use our human ingenuity to apply science to nature with more productive

[6] On the encounter of "self" and "other" see the works of Martin Buber and Emanuel Lévinas.

technologies – first to increase human ability, then to make agriculture more efficient and finally, to invest the surplus into mass manufacturing and a significant improvement in the standard of living.

The rising belief in the conquest of nature went hand in hand with the rise of the nation. Instead of the old politics of hierarchy, new politics in which we all saw each other as equal members of a nation opened up new possibilities. Mass literacy was no longer a threat to the elite, but a tool for national and human progress. Technological advances would become the basis of a thriving economy which would benefit all. Indeed, the democratic nation-state living in harmony with its neighbors seemed a convenient package through which to organize human communities.

The beliefs in the conquest of nature and in the nation-state were powerful ideas in the 19th and 20th centuries. Both beliefs are central in the narratives of Zionism, Arab nationalism, and other nationalist and modernizing movements. These beliefs are implicit in language that distinguishes between "developed" and "underdeveloped" (or "developing") countries.

Since the middle of the 20th century, economic development has been a primary narrative of the world community of nations. At the end of the Second World War, the Western powers were fearful of repeating the failed policies used at the end of the First World War, which essentially drained Germany of its resources and pride, setting the stage for another, escalated world conflict. They would not return to the rivalries of European colonial powers that had led to arms races and war, protectionist economics, the depression, and the repression of colonized peoples.

Instead, the Western powers had come to understand their relationship to the rest of the world in a different way. Europe and North America were "developed" societies, having passed from rural-agricultural societies to urban-industrial ones. Developed societies had more efficient farming, modern transportation systems, mass manufacturing, literate and educated populations, democratic politics, and higher standards of living. The road to world peace and stability lay in the development of the world community of nations, bringing the "developing" countries up to the standards of the "developed" countries. The United Nations would be the political framework that would encourage decolonization, and former colonies would become independent countries, on the road to development and prosperity. International financial institutions, preeminently the World Bank, would provide technical guidance and investment capital. With this outside support, underdeveloped countries would use their natural and human resources to make the transition to developed societies.

This is a narrative about closing gaps between the developed and the "underdeveloped" or "less-developed" world. This narrative about the conquest of nature and national development is deeply embedded in how we think about the global economic and political system. Since 1987, we commonly supplement the language of "developed" and "developing" countries with language of "sustainable development."[7]

"Development" is probably the most common official narrative of the "underdeveloped" countries of the world. "Development" of course is not the only narrative that national representatives tell about their countries, but it is the story that aligns their peoples with a widely held, globally shared story about how the future might and should, unfold. Israel often presents its story as one of development from a relatively poor to a relatively prosperous, highly industrialized, and technologically advanced country. Jordanian discourse speaks of it as a "developing" country, with national plans to use its limited natural resources to make a successful transition toward carving out a stable, prosperous niche in the world economy. Palestinian resistance to occupation is presented as the struggle of a people to control their own destiny and exercise their rights to develop their resources (Haddad, 2004).

Countries that are self-conscious about development think of water as a resource that is essential for human consumption, agriculture, and industry. They inventory water supply and manage it by increasing supply or, with much less enthusiasm, setting limits on demand. Development policies allocate water to personal consumption, agriculture, and industry. With large increases in population in the region,[8] the demand for water for human consumption has grown. Industrial technologies, while not the most intense users, do require water, and development plans have to make sure it is provided.

The most extensive use of water, however, is in agriculture. Jordan and Israel both subsidize water to farmers, and agriculture remains a major part of the Palestinian Authority's economy. Subsidization of agriculture is common all over the world for several reasons. Because national development aims at self-sufficiency, subsidies of water are rationalized as contributing to "food security."[9] Nationalist movements also typically have romantic attitudes about farming as a way of life, and this is another source of the willingness to subsidize agriculture. Farmers represent communities rooted in the land, custodians of the nation's oldest identity. For Jews, who were uprooted centuries ago, the communal agricultural kibbutzim and moshavim of the "pioneering" period in Israeli national development represent the replanting of national roots.

[7]See *Our Common Future* (1987) the report of the World Commission on Environment and Development, commonly referred to as the Brundtland Report, 1987.

[8]In 1880, the area between the Jordan and the Mediterranean had between 400–500,000 inhabitants. Today it has a population of more than 10 million. The Jordanian population has risen from under 600,000 in 1952 to almost 6 million in 2006.

[9]See Shuval (2004), for a critique of this position.

Traditional farming communities typically expect to be allowed their traditional allocations of water, and subsidization of the cost of the supply is usually necessary for this to continue. In places where ownership of the land is contested, keeping farmers working on the land makes a statement, and abandoned fields would make another kind of statement. Finally, many countries are worried about runaway rural–urban migration overwhelming the occupational opportunities and infrastructure of cities. These concerns apply in the Middle East as well and are another rationale for water subsidies to agriculture.

To meet the demand for water, Israel has dug wells to tap aquifers, built the National Water Carrier to distribute water from the Sea of Galilee throughout the country, has built and continues to build reservoirs to capture runoff from the winter rains, is developing techniques to reuse wastewater, and is building a network of desalination plants. Jordan, which is one of the most water stressed countries in the world, has built dams, dug canals, and taps aquifers. Palestinians, in contrast, have watched the intensive Israeli use of regional groundwater while they are prevented from responding adequately to their increase in need.

Most of the development of the water supply has come through diverting water which formerly flowed through the Jordan River to the Dead Sea. Today, the Jordan River flows into the Dead Sea at about 7–8% of its flow as compared with some 50 years ago.

The Dead Sea plays a particular role in the Israeli and Jordanian narratives of national development. The (Israeli) Dead Sea Works and the (Jordanian) Arab Potash Company, which are across the southern salt ponds from each other, work around the clock, evaporating the Dead Sea and extracting its minerals. These companies are major suppliers of fertilizers to Brazil, Australia, China, and the Arab world. Potash exports form a major source of income for the national economies of Israel and Jordan.

A large visual inside the Dead Sea Work's reception area shows how it situates itself within the national development narrative. Against a blue background, a picture of Theodore Herzl looks down on a quotation from "Altneuland" – his utopian novel, written over a century ago, which foresaw a revived Jewish homeland. Beneath Herzl, in Hebrew and English, in large black letters, the following quote:

> There stood the turbine sheds, and above them, on the slopes, there were extensive factory buildings. Indeed, wherever they glanced, as far as the eye could see, the lake was surrounded by great plants – power had attracted all kinds of industries. The Dead Sea had come to life again.

4. The Narrative of Regional Development

Understanding water policy from the perspective of national development alone would, however, be incomplete. The narrative of national development has been both challenged and supplemented – though certainly not supplanted – by a narrative of regional development. Narratives of regional development stress cooperation rather than self-sufficiency and competition. The regional development narrative goes like this: the neighboring countries of most parts of the world have never been self-sufficient. They trade with each other, providing larger markets for their farmers and manufacturers. Transportation networks that link neighboring nations to each other are as important in development as transportation networks linking different parts of one country. The successful development of any one country is more likely if there is peace and good relations among the countries of its region. The transnational flow of ideas breaks down national consciousness and opens up new possibilities for imagining identities. The road to a prosperous future lies in regional cooperation.

Regional consciousness in the Middle East is stimulated in part by the evolution of the European Union (EU) and other regional blocs in the world. The EU is a concrete, close-by example of successfully building prosperity through close regional integration. Elsewhere, the North American Free Trade Agreement (NAFTA) and movements toward free trade areas in Latin America are also based on narratives that project a more prosperous future through regional economic integration.

Arab countries have long been conscious of themselves as deeply connected to each other by a shared culture. The Arab League and the ideology of pan-Arabism express a shared regional political consciousness.

Those in the international community who are engaged in development work use the acronym MENA (Middle East and North Africa). This regional identifier is used by businesses, the World Bank, and other financial institutions, the US State Department and other government bodies, transnational NGOs, news agencies, and research centers. Since 2002, the United Nations Development Program (UNDP) has also focused on this as a distinctive region through the publication of its *Arab Human Development Reports.* The initiative promoted by Shimon Peres for a "new Middle East" was intended to integrate, in a constructive way, Israel into this regional identity.

The EU has been promoting a vision of another region, which partly overlaps with MENA. Beginning in 1995, the EU launched the Euro–Mediterranean Partnership (also known as the Barcelona Process), which promotes the development and cooperation of Mediterranean countries. In this way, the EU engages its neighbors to the south as a collectivity and devotes resources to common problems. Israel is a part of the Euro–Mediterranean Partnership, along with Algeria, Egypt, Jordan, Lebanon, Libya,[10] Morocco, the Palestinian Authority, Syria, Tunisia, and Turkey. This joint membership provides a context in which the development plans of these regional partners can be coordinated.

The Oslo Accords and the Jordan–Israel peace treaty both contained, in addition to their strictly political items, provisions for regional development. While water was not the only regional development item, it was important in both documents.

The Palestinian Authority's water supply is largely dependent on Israel, with the Authority's water distribution pipes linked to Mekorot, the national water company of Israel. Following the Oslo Accords, Palestinian and Israeli experts conducted a joint study of shared management of water resources (Feitelson and Haddad, 1994, 1998; Haddad and Feitelson, 1995, 1997). Administration of water supply to the West Bank and Gaza was placed in the hands of the Joint Water Committee. The anticipated negotiations on water did not take place, but the practical work administered by the Joint Water Committee continues. After the Second Intifada began, the Joint Water Committee called for all parties to restrain from damage to the water system or attacks on water maintenance and repair personnel (Israeli–Palestinian Joint Water Committee, 2001). Despite the continuation of the Joint Water Committee, there seems to be general agreement on two points. First, as a mechanism to move toward joint water management that is efficient and perceived as equitable, the Joint Water Committee has been a failure. Second, joint management of water resources is practical and desirable, perhaps even essential (de Châtel, in press).

Regional cooperation on water between Jordan and Israel has been more productive, with provisions guaranteeing Jordan access to water included in the 1994 Peace Treaty. While it appears from the official record that talks about regional cooperation over water began in the 1990s, covert, unofficial but important contacts go back further. Eliyahu Rosenthal, advisor to the Israeli Water Commissioner, recounts meetings in the Jordan valley in which he participated with Jordanians during the early years of Israel's existence, where they collectively outlined the share of water each would be entitled to draw (Rosenthal, 2003). Jordan's former Minister of Water, Munther Haddadin, now a development consultant, was himself also present at these meetings which he describes as extensive and valuable (Haddadin, 2004). These meetings, cooperative gatherings in tense times of heightened conflict, when Israel and Jordan were technically at war with one another, set the stage for the water management provision of the Israeli–Jordanian peace agreement.

[10]Observer status.

The Red Sea–Dead Sea Canal proposal before the World Bank reflects a move toward an explicit framework of regional development. The proposal implicitly acknowledges that the mutual exploitation of a shared resource could not go on indefinitely. As Nader El Khateeb, the Palestinian Director of FOEME, noted at the NATOASI, the diversion of upstream water for agriculture and the extraction of minerals for export through evaporation is a form of tacit cooperation for the destruction of the Dead Sea (El Khateeb, 2006).

El Khateeb's colleague, Gidon Bromberg, described the history of mutual exploitation as an example of "the tragedy of the commons" (Hardin, 1968). This much-discussed phrase has been used to describe a situation where a finite resource is available to multiple parties and there is no restriction on usage. Each party takes as much as possible, as quickly as possible, degrading and depleting the resource.

There are of course well-managed common resources in the world. In many places, the "commons" do not become tragically degraded but are preserved through active management. Common management requires agreement among the parties. There is, as yet, no formal joint management plan for the Dead Sea. In part, this may be a political issue. The Palestinian Authority has an interest in the Dead Sea, in addition to Jordan and Israel. Political considerations make it unlikely that the Palestinian Authority and the government of Israel could negotiate an agreement in the short term. The lack of a management plan may also reflect Israeli and Jordanian ambivalence about how to view the Dead Sea. They are each aware of the Sea's unique geography and historical significance. They are also aware of the economic value of the freshwater that is diverted both upstream and from surrounding springs and the minerals that are extracted from the Dead Sea itself.

With its unique landscape and cultural heritage, the Dead Sea could be a candidate for designation as a UNESCO World Heritage site, though it currently is not, and a formal, shared management plan would have to address the protection of the Sea.[11] To date, both Israel and Jordan have had a de facto policy of viewing agriculture and mineral extraction as more important than preserving the sea.

On a broader scale, the management of the Dead Sea is one aspect of the management of water in the region. Proposals for the regional development of water supply include a variety of megaprojects. While the Red Sea–Dead Sea

[11]Through this program, UNESCO seeks to identify, protect, and preserve the global heritage of humanity. So far, 812 sites in 137 countries have been listed, including 5 in Israel and 3 in Jordan. Designation depends on a country's commitment to protect and manage the sites it proposes. Some World Heritage sites are on national boundaries and their protection and management is jointly agreed upon. See: http://whc.unesco.org/en.

canal has been getting the most attention (e.g. Al-Alem, 2002), a shorter conduit from the Mediterranean to the Sea of Galilee or the Jordan River and a canal bringing water from Turkey through Syria to Lebanon, Jordan, Israel, and the Palestinian Authority have also been proposed. Each proposal shares common assumptions. The water problem in the region can be addressed as a problem of scarcity; therefore the solution is primarily the development of supply. Each megaproject would contribute supply to the region. Each involves large-scale construction. Each would be technologically up to date.

The argument for a regional development perspective is a strong one, even though there are serious practical difficulties: Hostility and violence continue; states in the region vie for influence; oil-producing states have vast economic resources that states without oil lack. Nevertheless, in the area of regional water management, initiatives continue. The Israel/Palestine Center for Research and Information (IPCRI) has convened two conferences on water in the Middle East (Twite, 2005). The Dead Sea Project has produced detailed studies done by a joint Israeli–Palestinian–Jordanian and international team.[12] FOEME with offices in Tel Aviv, Bethlehem, and Amman conducts research as well as engages in projects.[13] Several universities around the world have research projects on the Middle East's water resources. Projects associated with the Multilateral Working Group on Water, one of the five groups established in the early 1990s to supplement and reinforce the bilateral track in the Palestinian–Israeli peace process, continue. The Multilateral Working Group sponsored the compilation of a shared, detailed database on water (see e.g. Yellin-Dror et al., 2004) and a public awareness campaign. It also sponsors the Middle East Desalination Research Centre (MEDRC) in Oman, where there are twenty experts working with a US$1 million budget, undertaking research and development. In addition, the Global International Waters Assessment includes a project on integrated land and water management in the lower Jordan River basin (Assaf, 2004a, b).

These various activities all make sense in the context of a regional development narrative that supplements one of national development. There are transparent advantages to using a regional rather than a narrowly national narrative to build prosperity. Nevertheless, as the daily news reminds us every day, the shift is a hard one and many seem not to have made it. For all parties, the shift away from a strictly national narrative requires a change in perspective

[12]See: www.deadseaproject.org. See also Lipchin et al., 2005. One of the authors of this article, Eric Abitbol (as the director of Peacemedia-paixmédia), is a Dead Sea project researcher, focusing on water wisdom and tourism in the Dead Sea region.

[13]See: www.foeme.org.

in which the relationship with dominant ideologies, cultures, and practices needs to be redefined. International activist and development practitioner Brian Murphy (1999) argues that the future is not being imagined by those adhering to the dominant ideology, but by diverse groups and collectivities of people who are situated at least partially in the margins, on the fringes, in the periphery, in border areas or boundaries (Anzaldúa, 1999). Our group at the NATOASI struggled over 10 days with this as we sought to imagine another future for the way water might be managed in the region while acknowledging the current realities of states, ideologies, and fears in the region, realities which many of us carry in our daily lives.

5. Adapting To Nature and Letting Nature Take Its Course

Sometimes it is important to acknowledge the obvious. Narratives of national development and narratives of regional development are both narratives of development. As we noted above, the distinction between "developed" and "developing" countries came into use in the middle of the 20th century. "Development" is both a way of understanding the world and a vast array of practices which correspond to that worldview (Escobar, 1995). "Development" has its critics, and the critique of "development" also raises the question: if "development" is not the way to a better future, what is?

"Development" implies that the poorer countries of the world are or have been "underdeveloped." It is not original to note that this seems a peculiar way of looking at places where there has been a long history of human habitation and rich cultures. The Middle East is a prime example of how peculiar this perspective is. The Middle East has been inhabited for thousands of years. There is little that is pristine or underdeveloped about its landscape. Most places show the consequences of generations and generations of human impact and the ongoing presence of a growing human population.

In practice, "development" does not refer to this kind of slow, cumulative human impact. It refers instead to the use of powerful technology, which makes massive alterations to the landscape, in order to produce economically valuable goods and services. Modern forestry, mining, and fishing extract valuable resources at a scale unimaginable even 150 years ago. Agro-business transforms local agricultural fields into settings of intensive cultivation for the world market. Dams change both entire hydrological systems of the regions in which they are located and the biological systems which depend on local watercourses. Further, presented with the criterion of making massive alterations of the landscape to make it more productive, an environmental historian would question whether the Middle East is underdeveloped. The Middle East was, after all, a site of outstanding megaprojects in early antiquity – the construction of vast irrigation systems along the Tigris-Euphrates and Nile River systems.

Critics of "development" also note the destruction that has accompanied massive intrusions into the landscape. In order for large-scale development to be successful, part of the landscape is *sacrificed*, along with the ecosystems and history that exist upon it.[14] In the Middle Eastern context, one can think of the Jordan River and the Dead Sea as ecological "sacrifice zones" (Fox, 1999). No one wanted to turn the Jordan River into a sewage conduit. However, the value of the water diverted to agriculture appeared, to those doing the diverting, to be more economically, culturally, and politically important than the value of letting the water remain in the river. In the Dead Sea area, the same diversion of water and the value of its minerals on the world market have been important to meeting Israeli and Jordanian development objectives. The Dead Sea, and its surrounding communities and ecologies, are candidates for sacrifice in order to meet the development goals of the nations bordering on the sea.

The language of "sustainable development" tries to get around the destructive consequences of development by ensuring that development plans take long-term consequences into account. This language has been in broad usage since 1987, with the Brundtland Report of the World Commission on Environment and Development. Ambiguity and debate have accompanied its diffusion. Scholars and policymakers have differed among themselves about just what the phrase means. Businesses and governments have adopted its rhetoric, with varying degrees of clarity about goals, specificity of targets, and commitment to monitoring results. The global process of "development" continues – massive alterations of the landscape to meet human needs.

Despite the rhetoric, restraint based on long-term considerations seems rare. As the human population becomes aware of the magnitude of the consequences of climate change, it becomes clear just how radically the "development" agenda would have to be transformed in order to be compatible with a stable, nurturing global ecology. Some advocates of the narrative of development

[14]China's Three Gorges Dam has forced millions of riverside villagers from their homes, but it differs only in its uniquely immense scale from hundreds of other large dams. Forestry produces clear-cuts that go on for many miles. Mining has similar consequences. The USA extraction of coal for its power plants stripped the mountain tops of West Virginia bare, leaving poverty and pollution behind (Fox, 1999), as do many resource extraction processes in the resource rich but impoverished parts of the world. Even when the damage is unforeseen, sacrifice takes place. The irrigation systems of the ancient Middle East contaminated agricultural soil, contributing to the transformation of the "Fertile Crescent" into desert (Diamond, 2004; Wright, 2004). And, of course, no one in the nuclear industry intended to produce human exclusion zones around Chernobyl.

argue that it is still a credible view of how the future might unfold because human ingenuity (Homer-Dixon, 2000) will likely produce technological and cultural innovations adequate to the challenge. Skeptics who are conscious of past civilizational failures as well as successes are not so sanguine (Diamond, 2004; Wright, 2004).

Critics also object that "development" has been narrowly focused on economic production, most often pushing aside political, cultural, social, and ethical concerns. The narrative of "development" is grounded in the language of economics. The success of development has been measured in the growth of the Gross National Product (GNP) and associated indicators. Critics with other agendas – educational opportunity, health care, democratic institutions, social equity, workers rights, indigenous peoples' rights, environmental protection – have shown how the narrow focus on economic "development" can jeopardize these goals. They have proposed instead a calculus of progress based on the "triple bottom line" – economic, social, and environmental.[15] They have worked on creating a Human Progress Indicator or a Genuine Progress Indicator as alternative measurements to the GNP.

Furthermore, "development" costs money and puts investments at risk. Many countries have borrowed from the World Bank and its regional clones and invested in projects that have not produced a more productive economy, as promised. At the end of the day, these countries are left with debts, social dislocation, cynicism, anger, and environmental damage.

The narrow economic focus on GNP obscures the important question of who benefits given that development projects benefit some more than others. Elites who control land, investment capital, and access to the international market are well positioned to benefit from development projects. Civil servants in poor countries are tempted by the large sums which pass through their hands on the way from lenders to projects. Cynics also observe that the thousands of professionals who staff the institutions of the international development industry do better by it than many of their clients. "Development" may also be seen as concealing the maintenance and a perpetuation of global economic and political inequities. The development agenda is mostly set by the wealthier, Organization for Economic Cooperation and Developmen (OECD) and G8 countries, which control the resources for large-scale investments. Some projects do challenge the status quo, when "developing" recipients are able to exploit divisions among the developed donors.

[15]For a critical analysis of the Triple Bottom Line, see the work of Stephen Viederman, formerly President of the Jessie Smith Noyes Foundation, www.noyes.org (see Viederman, 2000; Murphy, 2002).

In our context, these criticisms of development are applicable to proposals for megaprojects as solutions to the challenge of integrated water management in the region. The proposed "Peace Conduit" or RSDSC carrying water from the Red Sea to the Dead Sea is the best known of the currently proposed megaprojects. Additionally, the construction of desalination plants along Israel's Mediterranean coast is well advanced, the construction of a water carrier from Turkey through Syria to Lebanon, Jordan, and Israel has its adherents, and there is a proposal to build a large desalination plant in Gaza city. Following the logic of development projects, these all aim at large increases in the supply of a scarce resource through the intense application of technology.

What would the critics of "development" say about these projects? They would argue that responding primarily to the agenda of increasing supply brushes aside the option of cultivating social attitudes and political programs which restrain demand. Even with better mechanisms for supply, water is a limited resource and, certainly in the Middle East, costs will increase accordingly. As in the field of energy, conservation in order to reduce demand makes managing limited resources for the long-term much easier.

The priority given to megaprojects to develop increased water supplies also pushes off the table the strategy of dealing with water scarcity by examining distribution. Palestinians, whose water supply is almost entirely controlled by Israel, live with much less water than Israelis do. Of the various water infrastructure projects proposed, the only Palestinian Authority project, the Gaza city desalination plant, appears the least likely to be built in the foreseeable future. The first Israeli desalination plant on the Mediterranean is already built and others will follow. Israeli plans anticipate that water from these plants could be used to supply Gaza, the West Bank,[16] and Jordan. Palestinians and Jordanians are understandably cautious about this approach to increasing the water supply, as this source would be controlled by Israel.[17]

Inevitably, considerations of distribution raise critical issues of agency, control, and self-determination. A future regional water system in which the

[16] In 2004, Israel outlined a plan to pipe desalinated water from Caesarea on the Mediterranean coast to the West Bank. Uri Shamir of the Israel Institute of Technology in Haifa described the desalination project as the "only viable long-term solution" for supplying drinking water to the West Bank (see Shamir, 2004; Dreizin, 2004).

[17] On Palestinian concerns see Phillips et al. (2004) and Haddad (2004). An important section of the 1994 peace treaty between Jordan and Israel assured Jordan of a greater supply of water. In 1999, Israel announced that due to the emergency of the current drought, it would not be able to comply with these treaty obligations. In response to strenuous Jordanian objections, most of the water allocations to Jordan were restored.

Palestinian Authority and Jordan will be dependent on Israel for supply cannot be imagined as viable in the medium to long term.

In addition to political questions about the distribution of water, megaprojects of water infrastructure obscure how water is allocated to different sectors. Most water in Jordan and Israel, as in most countries in the world, is used for agriculture. Given the restriction on Palestinian water supply, the percentage of water used for agriculture is not clear, though believed to be around two-thirds of available supply. Even with a continuing increase in population, there is available water to meet human consumption needs in the region (Feitelson and Chenoweth, 2002). However, critics would ask about the wisdom of building water megaprojects to prop up the local cultivation of water-intensive crops for export. They would also ask whether this use of water benefits small farmers or large landowners who use foreign workers.

Megaprojects have unintended, unforeseen effects. Large-scale intrusions into natural processes almost always have more uncertainty than small-scale interventions. The complex chain of interactions in nature is imperfectly understood. To make matters worse, planning studies have financial limits. Some possible consequences are left unexamined because they are not considered important enough risks to be studied (Linkov, 2006).

The vulnerability of technological infrastructure is a concern. RSDSC pumping stations, pipelines, desalination plants, and similar installations would be in a part of the world where warfare and violence must be factored in. In conventional warfare, incapacitating the water system could significantly weaken an enemy's ability to continue fighting. During protracted periods of low-intensity violence, irregular combatants using rockets might aim to weaken the enemy's morale by attacking water megaprojects. It is not clear, for example, whether the proposed feasibility study for the peace conduit will include a "peace and conflict impact assessment" examining the consequences of possible warfare.

Cost is also an issue. Could the billions of dollars proposed for megaprojects be used in better ways? Perhaps something better could be done with the \$15.5 (World Bank, 2005) million required for the Red–Dead feasibility study or the estimated \$5–10 billion (Beyth, 2002) required for the construction of the canal and its \$5 million annual operating costs?[18] With megadevelopment projects, it is often the case that costs significantly surpass estimates as well.[19]

[18]All figures in US dollars.

[19]Fisher's economic analysis (2004) indicates the complexity of determining the comparative costs of different water supply projects.

These criticisms of “development” as a narrative of how to manage human–nature relationships and as a strategy for a better future raise difficult questions. The narrative of “development” tells us that in most of the human past, life was harsh because we did not understand nature, nor did we have the powerful tools to extract value from it. Now, we have those tools. If we use them wisely and responsibly, and apply them on a grand scale, we can help the poor countries of the world to progress closer to the standard of living of the rich countries. The critics of development challenge that narrative as one which ignores important data about how both the natural and social worlds work and change. They conclude that the narrative of development is not an appropriate guide to the future, neither as a projection of what a possible future might look like, nor as a set of practices to get to a desirable future. If “development” is not the way to a better future, what is or might be?

A narrative that replies to this question is emerging out of environmentalism and other social and political movements. It begins by giving ourselves the space to think creatively about our predicament, challenging assumptions that have produced deterministic outcomes. Trottier (2004) observes that conventional discussions of water take for granted and are confined by three ideas – that the state should be the central arbiter of water use, that water should be considered a public good and an object of public policy, and that policy recommendations should be based on quantitative models drawn up by scientific experts. These ideas, she argues, are in fact, products of the 20th century. They make water megaprojects the “natural” solution to water management challenges and obscure other ideas about water management that could lead to alternative policy approaches and choices.

In the emerging alternative narrative, the acquisition of powerful modern technology is portrayed as a mixed blessing, and one which must be used selectively. Humanity has long practiced both the strategies of adapting to natural limits and of developing technologies that alter nature to our purposes. Unprecedented modern technologies have tipped the balance away from adaptation and led us to act as if natural limits no longer applied.

We are now becoming aware of the impact of our massive technologically driven modifications of nature and have the opportunity to redesign the ways we live in order to work with natural processes rather than massively altering and destroying them. In contrast to a narrative of “development,” a narrative which might have as its label something like “adaptation” rather than “development” or “letting nature take its course” could point us toward a future of human–nature coexistence. The processes we choose to pursue might also enable peaceful human–human relationships.

Adopting a narrative of “adaptation” or “letting nature take its course” would mean recognizing that the natural world can only retain its equilibrium

(Lovelock, 1979, 2006) if we do not make excessive demands on it. The emphasis on restraint is consistent with the incorporation of the "triple bottom line" into the narrative, and the resistance to excessive consumption – measured perhaps by calculating ecological footprints. As a strategy of social well-being, once adequate survival needs of humans and biodiversity are taken care of, equity is clearly more important than absolute wealth. In a world society that claims a commitment to equity, the gap between the top and the bottom matters (Prugh and Assadourian, 2003). The social bottom line is about agency, distribution, meeting needs, and implementing values rather than artificially promoted desires. This can be part of an emphasis on adapting to nature rather than massively altering it.

Using the narrative of "adaptation" or "letting nature take its course" does not mean becoming passive or fatalistic. But it does mean seeing ourselves as part of a larger, complex ecological system. There are real limits in that system; we are obligated to treat it with respect. This approach is not entirely absent in the region. Birdwatchers – scientists and amateurs alike – know that the Jordan Rift Valley is one of the world's most important migration routes. They have so far convinced the governments of Jordan and Israel that they have an obligation to maintain the landscape required by the birds. In the north of Israel, the government came to realize that the draining of the Hula Valley, while controlling mosquitoes and opening up rich farmland, damaged the water system. What was once thought of as a "swamp" good only for draining, was retroactively understood to be a "wetland" that conserved and purified water; as a result of this changed perspective and understanding, much of it has been restored and many of the migratory birds once dependent on the Hula have now returned.

There are implications of this approach for policy toward the Dead Sea, the Jordan River, and for the broader question of regional water management. What would be different if a narrative of the future that promotes adaptation to nature were used to plan for the Jordan River–Dead Sea Watershed? Perhaps the first difference would be to see the Jordan River and the Dead Sea as complex places worth preserving and not just as resource-rich landscapes to be sacrificed in the name of "development."

Growing numbers of people, communities, and organizations, including FOEME, have begun to promote this change. FOEME's recent publications on the Jordan River portray, with the help of maps and pictures, its ecological importance as a wetland, its role in the biannual bird migration, the unique and extensive historical sites beside the river, its remaining places of natural beauty, and its potential as a peaceful meeting place for the peoples of the region (Bromberg, 2004; FOEME, 2005).

If the Jordan River and the Dead Sea were restored rather than sacrificed in order to increase the water supply, what would water policy look like? Water policy would work within the twin understandings that water is a limited resource and that reliance on megaprojects carries risks. Learning to live within limits may in the long-term carry less risk. The objective of asking societies to live within limits is not to ask people to endure hardship, but to have them become partners in acting ethically in the use of a limited resource. This involves cultural norms that restrain demand, promote systematic conservation measures, and in general, align the use of water with values of caretaking and custodianship. If Israelis link in their minds their water use to the water use of their neighbors, restraint would be a sign that they know they are in the Middle East and intend to act like good neighbors.[20]

Water policy throughout the region would also involve public discussion of wise use as well as of the implications of increasing production. An important part of the alternative narrative involves the further diversification of both the narratives themselves and the ways in which they are created. The process of creating public conversations[21] throughout the region may generate insightful analysis and critique, evaluating the merits of different approaches to development and society more broadly. These may even be imagined in a multicultural, multinational context, perhaps bringing Israelis, Palestinians, and Jordanians together to further explore the issues, even generating new options. They could be based on a framework of questions, generated by both "experts" and the rest of society, which rest on the challenges currently being faced throughout the region. The deliberations and answers to such questions may surprise in the insights they provide about the region's people and their willingness to both participate in defining and in transforming the region's water systems.

Themes for public discussion and evaluation could include issues of water for the agricultural sector and the implications of reducing the current allocation, building on current opinion and alternative insights. Papers have been published and research continues on which crops of high value require less water (Assaf, 2004a,b; Solowey, 2003). The conversion of agriculture to these crops would limit the demand for additional water allocations.

The growing literature around the world on river restoration should give some practical models to adapt for the region (Assaf, 2006). River restoration is not about cosmetics such as planting picnic groves by polluted rivers. Riverbanks are historically places where life flourishes, places that add value to

[20]See the FOEME "Good Water Makes Good Neighbours Project," funded by Wye River Initiative and the European Union. This initiative is on the Green Line and brings together Israeli, Palestinian, and Jordanian villages.

[21]See the work of the University of the Streets Café in creating public conversations and popularizing discourses of social change; http://univcafe.concordia.ca. See also the work of the Public Conversations Project; www.publicconveresations.org.

the economy and support long-term sustainability to the ecological region. The initial work by FOEME on what a restored Jordan would look like is developing a picture of how many small projects could cultivate a watershed treasured by farmers, tourists, and nature lovers. The benefits of a restored Jordan and a stabilized Dead Sea would complement each other. This initiative could also promote rainwater harvesting in the wetter areas of the region, efficiencies in technologies for water distribution throughout the region, further water reuse and recycling, and any number of alternative and original ideas.

A narrative that sees the past, present, and future as a story about adaptation to the environment, as a story of learning to live within limits while being creative about the future, is not just a story about human–nature relationships. There is an ethical dimension to it, a recognition of the dignity of living with respect for the needs of others. A narrative about "adaptation" or "letting nature take its course" cultivates an attitude of responding to challenges by thinking about the existence of diverse and enmeshed people and communities within a larger ecology. In contrast, a narrative of development implies an attitude of using power to get results. A changed and evolving narrative about human–nature relations in the region may contribute to the transformation of the dominant narratives about "inherently conflicting" human relations in the region.

Many of the insights and recommended courses of action outlined above draw on the extensive work underway in the region and internationally to try and address some of the critical water and development issues facing Israelis, Palestinians, Jordanians, and others in the Middle East. They reflect a search for alternatives to national and regional development agendas. Yet, a note of caution is essential. We may outline all sorts of visionary plans as academics, policy developers, international development experts, and government authorities, however, these plans, insights and recommendations must be considered as part of a relationship-building process between the people, communities, and states of the region. They must also be flexible enough to accommodate the energy and creativity contained within these changing relationships, as the relationships diversify, expand, and deepen. As things begin to change, the future may look completely different than currently feared.

6. Conclusion

Today, the Dead Sea is at 417 m below sea level. It is dropping at about 1 m vertically per year. The chemical industries continue to extract resources, and the Jordan River is little more than a sewage conduit during summer months. Distant are the days when people could bathe safely in the sacred river's water.

Today, pilgrims coming for baptism at Bethany, inspired by the belief that Christ was blessed by the River Jordan take their health into their own hands.

With the Jordan River unsafe, the Dead Sea dropping, sinkholes appearing, development stalled, and deep concern emerging from different sectors, one can safely conclude that something must change, that current practices sustained by national and regional development narratives are having a detrimental impact on the water ways and basic life systems of the region.

Our workshop had begun with a challenge to think about security as human security and to think about environmental security as a type of human security. Our argument about reframing questions of regional water management from questions of "development" to questions of how to adapt to nature and be a part of it parallels that shift.

There can be no significant effort to address the current water-related insecurity without creating the political and cultural space for alternate practices and proposals to be imagined and implemented. In the case of the Dead Sea this would mean going beyond national and regional development interests and reevaluating the "value" of the region's resources and ecologies in a broad framework. This approach would take into account the rights, needs, and creativity of Israeli, Palestinian, and Jordanian communities involved. It would claim as its next point of departure a real consideration of the long-term future of the region, as a place of unrivalled historical, ecological, and cultural wealth.

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SECTION I

WATER RESOURCES IN THE MIDDLE EAST

FRESH WATER IN THE MIDDLE EAST AND NORTH AFRICA

SOURCE OF CONFLICT/BASE FOR COOPERATION

DAVID B. BROOKS*
Friends of the Earth Canada, 300-260 St. Patrick Street, Ottawa ON K1N 5K5, Canada

Abstract: With few exceptions, the nations of the Middle East and North Africa (MENA) have already reached or are fast approaching the limits of their indigenous water supplies. Some forces, such as higher prices for water, increased efficiency, and institutions for bi- or tri-national management of shared water bodies, can (and likely will) mitigate their problems. However, others, such as climate change, ongoing conflict, and higher populations and incomes, will exacerbate them. Sustainable water use in the region requires a shift from the historic emphasis on increasing water supply to options for reducing and reallocating water demand. Technology is available, and the economics are favorable. What is lacking are innovative institutions for, and better management of, the limited freshwater resources. Because so much of the region's fresh water is used for irrigation, and because agriculture is so embedded in regional societies, the most difficult part of the shift will depend on a gradual return to predominantly rainfed farming methods.

Keywords: fresh water; irrigation; Middle East and North Africa (MENA); rainwater harvesting; supplemental irrigation; virtual water; water conflict; water management; water institutions; water recycling; water conservation; water scarcity; water use

> *A certain gentile asked Rabbi Joshua: "You have festivals, and we have festivals. We do not rejoice when you do, and you do not rejoice when we do. When do we both rejoice together?" "When the rain falls," answered Rabbi Joshua.*
>
> Midrash Genesis Rabbah,13:6

*To whom correspondence should be addressed. David B. Brooks, Friends of the Earth Canada, 300-260 St. Patrick Street, Ottawa ON K1N 5K5, Canada, dbrooks@foecanada.org.

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1. Introduction

Fresh water has been the key natural resource limit on development for as long as we have a documented history in the Middle East and North Africa (MENA).[1] Both the Hebrew Bible (Old Testament) and the Koran are full of references to water, and the religious law deriving from them – Halakhah for Judaism; Sha'aria for Islam – go into great detail about how water is to be used and protected in peacetime and in war. Still today, in the so-called petroleum era, fresh water remains the natural resource of greatest concern to the bulk of the population, and by far the most important natural resource for their livelihoods.

MENA's water problems originate in a unique combination of natural and anthropogenic forces. Some regions of the world are drier than MENA, and others have higher populations or larger economies. However, no other region of the world includes so many people striving so hard for economic growth on the basis of so little water: MENA has 5% of the world's population but only 1% of its fresh water (Raskin et al., 1996). Excluding island and city states, there are only 20 nations with internal renewable freshwater availability below 1,000 m^3 per capita, a commonly used determinant of water stress; 15 of them are found in MENA. (The others are Hungary, South Africa, and three countries in East Africa). Not surprisingly, much of the history and the culture of this region reflects the dominant role of water as the limiting factor in development (Biswas, 1994; Isaac and Shuval, 1994; Rogers and Lydon, 1994; Biswas et al., 1997; Amery and Wolf, 2000; Hillel, 2004), as well as the source of many of its conflicts (Kliot, 1994; Shapland, 1997; Brauch, 2003; Fisher and Huber-Lee et al., 2005).

In almost every MENA nation, water stress stems from three interacting problems:

Quantity: The demand for fresh water almost everywhere in the region exceeds the internal, renewable supply.

Quality: Much of the region's limited water supply is naturally saline, and large volumes are polluted by growing volumes of human, industrial, and agricultural waste.

[1]For all practical purposes, MENA is equivalent to West Asia and North Africa (WANA); the latter is more common in United Nations documents, and the former elsewhere.

Equity: The same water sources are subject to competing political demands – in some cases from different sectors within one nation; in other cases, between nations where the water flows across, along, or under an international border.

Water quantity has always been a source of stress in MENA. Water quality is a new problem, but is coming to dominate concern in many parts of the region. And the politics of water is probably of greater concern in MENA, where it is subject to regular negotiations at local, national, and even international levels, than anywhere else in the world. None of the three sources of stress is independent of the other two, and to a considerable extent they need to be resolved together. As an article on the Israeli–Palestinian dispute over water noted that "…political decisions will become obsolete if environmental issues are not addressed promptly and effectively" (Lautze et al., 2005). This chapter will begin with a review of the hydrological situation in MENA, and then address the three sources of stress in the order given above.

My five main conclusions are:

- First, the key thread that must be followed to identify routes to relax water stress is the political economy of water. Of course, that thread is constrained by the hydrogeological conditions, but they merely set limits; they do not determine results. As Allan wrote (2002), "natural resources such as water do not determine socio-economic development; on the contrary, socio-economic development determines water management options."
- Second, stresses stemming from inadequate supplies of fresh water in MENA are likely to be felt more keenly, and to be more politically disruptive, within nations than between nations. As a result, internal conflicts over water will be common whereas international wars will be rare if they occur at all.
- Third, the greatest security threat in MENA is unsustainable patterns of freshwater use. Excessive withdrawals and continuing degradation of both surface and underground water are ubiquitous, and, in the absence of major policy change, will pose increasingly difficult problems of human security.
- Fourth, none of the sources of stress can be relieved unless much greater efforts are made in every MENA nation to increase the efficiency with which water is delivered and used. Technology is available, and the economics are favorable; the question is whether there exists the political will to make the necessary demand-side adjustments.
- Finally, though adequate supplies of fresh water are essential for human security in MENA, water is far from the only issue; today's insecurity cannot be resolved entirely within the water sector.

2. Physical Sources of Stress

In a rough way, MENA nations can be divided into three groups:

- Iran, Iraq, Lebanon, Sudan, Syria, and Turkey are fairly well endowed with water;
- Algeria, Egypt, Israel, and Morocco form a middle group;
- Jordan, Libya, Tunisia, and countries of the Arabian Peninsula are poorly endowed.

For Palestinians, the West Bank is relatively well off but the Gaza Strip is perennially short of water.[2] National averages for nations such as Egypt and Iraq are heavily influenced by major rivers; they really consist of narrow bands of fertility on each bank of the river with much dryer terrain extending over huge areas beyond. More important, all MENA nations exhibit one critical characteristic: *secularly declining water availability per capita* – and this is a long-term security threat that is far greater than their limited freshwater endowment.

2.1. GEOGRAPHY AND CLIMATE

The MENA exhibit sharp variations in physical geography and climate. Coastal plains merge over a few kilometres to mountain ranges, which then plummet to rift valleys with the lowest land elevations on earth. Average annual rainfall is about 250 mm, but averages are highly misleading. Vast areas of MENA are hyperarid, with rainfall typically 5 mm per year – a figure that implies a torrential downpour of 50 mm once in 10 years. However, those areas are virtually devoid of permanent settlements, and, petroleum production aside, they are not major factors in regional water economy. Rather, most of the people and the cities, along with the bulk of economic activity, are found in those parts of MENA that are semiarid with rainfall ranging between 250 and 750 mm per year. Even in these areas, potential evapotranspiration exceeds rainfall in almost every month of the year; in simple terms, more water would evaporate than what actually falls. Surface bodies of water, such as Lake Nasser in Egypt, lose metres of water each year to evaporation.

Sharp seasonal and spatial variations of rainfall are common throughout the semiarid parts of MENA. Most of the rain will fall in four winter months; the

[2]Extensive data on fresh water availability and use in MENA can be found in Gleick et al. (2002) and in UNESCO (2003).

other eight months are dry. The thin coastal strip of Lebanon gets 2,000 mm of rain per year; the Beka'a Valley, just 50 km to the east (but across the Lebanon mountains), gets only one-tenth as much. In the north of Israel, rainfall may reach 1,000 mm per year; a day's drive southward at Eilat, it is only around 50.

Low rainfall causes problems, but, so long as the pattern is predictable, engineering and economic calculations, just as with traditional lifestyles, can learn how to deal with it. So far, as water security is concerned, the dominant hydrological characteristic in MENA, as in other semiarid areas, is not seasonal or spatial but annual (Rogers and Lydon, 1994). Joseph's dream of seven good years and seven bad years in the book of Genesis reflects normal, not abnormal, climatological conditions in Egypt. Statistics on average rainfall may be mathematically accurate, but they convey little useful information. Water planning and management must focus on extremes and on risk minimization, not on averages and maximum utilization. MENA is one of the few areas in the world to suffer from floods as well as droughts. It is as important to design structures that can withstand high peak flows as to develop livelihood patterns that can survive extended low flows.

All current evidence is that global climate change will only make the freshwater situation in MENA worse. Different climate models yield different results for many parts of the world, but almost all models project higher temperatures, lower rainfall, and longer droughts for MENA (Stakhiv, 1998; Arnell, 1999; Milly et al., 2005). Even if such models remain highly uncertain in amplitude, the trends have broad agreement. It would be foolish to ignore their results, and particularly to do so when working out political compromises on water (Lautze et al., 2005). Further results will be available in the fourth report of the Intergovernmental Panel on Climate Change, due in 2007 and which is supposed to focus on fresh water.

2.2. PRINCIPAL SOURCES OF WATER SUPPLY

Rivers are the best-known sources of water, and MENA includes two of the greatest in the world: the Nile and the Tigris-Euphrates. There are a few medium-sized rivers, mainly in the eastern Mediterranean region, such as Jordan and the Orontes. Finally, there are numerous short or ephemeral streams that are typically fed by springs in the mountains and that flow down to the sea or seep into the desert. Very few natural lakes occur in the region.

With the exception of some of the coastal streams, the majority of rivers in the Middle East, even those of modest size, are international. (North African nations are larger, and most of their rivers are national). The Litani in Lebanon is one of the few rivers with stream flow exceeding 500 MCM[3] per year that lies entirely within one nation. The Nile, in contrast, has 11 riparian nations, with the bulk of the flow originating in Ethiopia (where the Blue Nile rises). The Tigris and Euphrates share four riparians, with about two-thirds of the Tigris and nearly all of the Euphrates rising in Turkey. The Tigris and the Euphrates each share four riparian nations, but the bulk of the water – two-thirds of that in the Tigris and 95% of that in the Euphrates – originates in the highlands of southeastern Turkey.

Though surface water gets most of the attention, the real aquatic prizes in an arid region lie underground where water is not subject to evaporation and less susceptible to pollution. (Biblical stories rarely refer to conflicts over surface water, but there are many stories about conflicts over wells). Rock formations containing water are called aquifers, and they are found at depths below the surface of the earth from a few metres (and therefore accessible by hand-dug wells) to hundreds or even thousands of metres deep. (It is rarely economical to pump water from depths exceeding a few hundred metres). Aquifers can be divided into two main types.

- Some are replenished regularly by rainfall and thus constitute renewable resources – though flow from the recharge area to outflow in springs may take years, or even centuries. If carefully managed so that extraction equals inflow, levels in renewable aquifers will be constant.

Other aquifers contain water that was buried in isolated sediments millions of years ago ("fossil water") and thus constitute nonrenewable resources; once pumping begins, availability declines. Perhaps as a form of cosmic compensation, most of the large fossil aquifers occur in arid regions. For example, the Nubian Aquifer underlies 2.5 million km^2 of four nations: Chad, Egypt, Libya, and Sudan. The somewhat smaller Disi Aquifer underlies parts of southern Jordan and Saudi Arabia. It is currently used to supply drinking water to the city of Aqaba, but will soon be supplying water to Amman (more than 300 km away and nearly 1,000 m higher in elevation), both of which will require a lot of electricity for pumping in a country that is almost as short of energy as it is short of water. The size of the aquifer can be inferred from the expected delivery capacity of 90–100 MCM per year for 100 years (Halasah and Ammary, nd). Unfortunately, many fossil aquifers originated as seabed sediments, and they contain elevated levels of salts that make their use problematic. One remarkable set of aquifers outcrops offshore in Chekka Bay in northern Lebanon with a volume that is six to seven times the low flow of the Litani River, and with such

[3]MCM = million cubic metres.

force that one can literally drink from the surface of the sea (Ghannam et al., 1998).

Over time, as surface sources have become fully committed and as technology has permitted deeper drilling, there has been a shift from surface to underground water. Even so, only about 10% of total supply for the region comes from underground sources. However, in Israel and Jordan, the share of underground water in total supply approaches 50%, and in the Arabian Peninsula 100% (desalination to one side).

Underground water does not respect national boundaries any better than does surface water. Most of the larger aquifers are in fact international waters, but, at present, there is no formal international law that governs their use. International law for surface water is, in general, appropriate for underground water, but it is much more difficult to apply. The best approach involves some form of joint management by the nations that occupy the surface over the aquifer, but it is rarely considered. The Mountain Aquifer that underlies the mountain ridge in Israel and Palestine is one of the few exceptions (Feitelson and Haddad, 1998, 2000; Daibes-Murad, 2005; see also the collection of six articles on transboundary aquifers in the June 2003 issue of *Water International*).

Few opportunities remain for further development of major rivers in the countries under study, and the sources that are available will cost two or three times as much per cubic metre. Good dam sites are not common in MENA, and, even where they do occur, high rates of evaporation limit their value. Exceptions are found in upstream countries, such as Ethiopia and Turkey, but further development there would reduce flows downstream (Shapland, 1997). Major freshwater aquifers remain to be developed (indeed, to be discovered), but they are likely to be deeply buried, contaminated with salts, or far from points of consumption, any of which increases the cost of development. Nevertheless, the share of water drawn from aquifers is bound to grow, especially to supply urban areas, where consumers can pay higher costs than can farmers.

2.3. ALTERNATIVE SOURCES OF WATER

In addition to the conventional sources of fresh water, there are a number of sources that currently supply only small quantities of water but could potentially supply much more. They can be divided into two groups depending upon a pair of criteria that tend to move in parallel:

- Low Capital/Decentralized
  - Rainwater catchment from roofs
  - Rainwater harvesting in fields
  - Use of brackish (saline) water for irrigation
  - Desert dams

Aquifer recharge
Storm runoff

- High Capital/Centralized
    - Desalination of sea water
    - Desalination of brackish water
    - Imports of water by sea using tankers, pipelines, or medusa (large plastic) bags
    - Interbasin transfers overland by canal or pipeline
    - Cloud seeding[4]

Most of the low-capital/decentralized options have long historical roots, and are not only technically proven but also cost-effective compared with the cost of developing new dams, deeper wells, or longer pipelines. Some, such as rooftop rainwater catchments, produce only small total quantities of water, but the water is potable. (The more difficult problem is to store the water so that it stays clean during the dry months). Spate irrigation based on storm water flows has been used for centuries as an effective, if quantitatively unreliable, source of supply. Rainwater harvesting in fields (Pacey and Cullis, 1986; Agarwal and Narain, 1997), as with the construction of small barrages and microcatchment management, appears in various forms around the world. The Nabateans – a tribe that flourished in the last five centuries BCE and that built Petra – left water cisterns and harvesting systems that are still visible in the Negev desert of Israel and elsewhere (Evenari et al., 1982). Today, traditional rainwater harvesting is being extended through use of global positioning and computer optimization among slope, soil type, and crop selection to permit agriculture in areas of 100–200 mm of rain per year. Use of brackish (saline) water containing 500–2,500 ppm of salts (seawater contains 33,000 ppm) also offers considerable potential (Stenhouse and Kijine, 2006). With careful crop selection, even higher levels of salt can be tolerated. However, careful farm management is needed to optimize the balance between saline and fresh water, and to rotate crops appropriately. As well, more research is needed to determine the long-term effects on soils from repeated applications of brackish water.

Perhaps most promising among all the lower cost ways to improve productivity of traditional agriculture in MENA is what is called supplemental irrigation. Supplemental irrigation is a way of enhancing rainfed agriculture by providing small amounts of additional water – much less than is generally

[4]Cloud seeding attempts to increase precipitation by dispersing substances – generally silver iodide or dry ice (frozen carbon dioxide) – into clouds in order to stimulate the formation of water droplets or ice crystals, which then fall to earth.

regarded as optimal for plant growth – critical times in a plant's life (Oweis et al., 1999). It can increase yields by factors of three to four, and greatly reduce the risk of crop failure in years of low rainfall, at costs that are only a fraction of what modern full-scale irrigation requires. As with rainwater harvesting, supplemental irrigation aims to maximize returns per unit of water instead of per unit of land.

With the exception of cloud seeding, which has been practiced in some countries for years, the high-capital/centralized systems are too expensive for widespread use. Partial exceptions must be made for direct imports of water and for desalination. Turkey is the one country in the region that appears to be both willing and able to consider water exports. A full-scale experiment is underway to deliver water from the Manavgat River in south central Turkey to North Cyprus. A plan to ship large quantities of water to Israel has now been canceled because of high costs and the failure of Israeli demand to grow as fast as expected. First efforts in Turkey focused on huge plastic bags containing 20,000 m^3 of water ("Medusa Bags") pulled by tugs, but technical problems arose and operations have now shifted to the use of refitted tankers. Despite these experiments, neither of the two routes – Turkey to North Cyprus and Turkey to Israel – was based purely on market considerations. Both reflect political considerations more than economic or agricultural needs.

Seawater desalination is of course the ultimate, unlimited source of fresh water – provided one has lots of surplus energy or the money to buy it. All "desal" technologies use vast quantities of energy, so it is not surprising that two-thirds of the world's capacity is located in the region where there are low-cost oil reserves and heavy oil left after refining. However, technological development has been steady, and on-site costs now fall below $1 per cubic metre of potable water. Such costs are less than twice what urban consumers already pay in Israel, well below those paid by people who receive drinking water by truck, as do many in rural parts of MENA, and even further below the price of bottled water sold throughout in the world. However, they are very much above what most urban consumers in MENA are used to paying.

Desalination will play a growing role in MENA nations. At present, a number of new desal plants at a scale of about 50 MCM per year are under construction in Israel, and others are going up elsewhere in the region. However, even with technological advances, seawater desalination is a source of supply that is only within reach for high-value water uses, notably household water in urban areas. It is unlikely ever to be cheap enough to play any role in agriculture, except perhaps for farmers producing very high-value crops (as with flowers flown to Europe on a daily basis).

All the other high-capital/centralized water projects share two characteristics that limit their acceptability: they have to be built at a large scale to bring unit costs down, and they cannot be built in modules (a canal or pipeline has zero value until it is complete). The global history of megaprojects is mixed; few have lived up to expectations, and most have had unexpected, adverse side effects. Ultimately, the most important question to ask is: Why build it at all? And this question can only be answered if one first asks: What problem is the project trying to solve? In many cases, the goal is to increase agricultural output, particularly of export crops, but the cost of the project is so high that it could only be justified for drinking water.

None of the foregoing means that all megaproject options should be dismissed, but rather that they should be approached critically. It is not up to the critics to prove that the project is not viable or has adverse side effects. Just the reverse: It is up to the proponents to show that it is viable, and that adverse side effects – their presence can be assumed – are not so great as to cancel the gains. Even then it may be difficult to make a clear choice because the uncertainties are so great.[5]

2.4. RECYCLING WASTEWATER

The one other significant "source" of water in MENA is recycled wastewater, mainly from urban sewers. Most cities in MENA have sanitation problems, and the need for new strategies to provide for growing populations is at least as much a driving force for the increasing use of wastewater as is any shortage of fresh water (Brooks et al., forthcoming). At present, far too much sewage goes untreated into the sea or into any convenient wadi.

The use of treated sewage water for irrigating crops is now accepted practice in Egypt, Israel, Jordan, Morocco, and Tunisia. (In some countries, raw sewage continues to be used, which risks the spread of cholera and other diseases). Despite common perception, there is no objection in Islamic law to use of reclaimed water for any use provided it is treated to an appropriate level (Tortajada, 1998; Faruqui et al., 2001). Other uses include recharging aquifers, creating green belts, fixing sand dunes, watering golf courses, and providing cooling water for industry. Though technically possible, high costs of treatment preclude direct use of wastewater for household use, and no MENA nation advocates this use. Even agricultural use requires a substantial investment in physical infrastructure to treat and move wastewater, as well as institutional infrastructure to ensure that it is used effectively and safely (Scott et al., 2004).

[5] See for example discussion of the proposed Red-Dead canal in the electronic review of Middle Eastern affairs: *Bitter Lemons-International* 3(23) for 24 June 2005 at www.bitterlemons-international.org

By early in this century, recycled water will come to dominate as a source of irrigation water for many countries in MENA. Already, Israel is reclaiming over half its available wastewater, Jordan one-quarter, and Tunisia one-eighth. (These figures are both uncertain and changing rapidly). Depending on the degree of treatment, recycled water can be used for nonfood or food crops. Only water that has received tertiary treatment, which implies marginal costs (above those of sewage collection) of at least $0.15/m^3, can be used for food that is eaten raw. In Tunisia, tertiary treatment of wastewater is reported to add 15–20% to the cost of secondary treatment, but total cost is still 30% below that of water from a new dam (Tunisian case study at the IDRC Forums[6] on wastewater recycling). As partial recompense, the nutrient value of recycled water is high, and, with appropriate controls, will be eagerly sought by farmers.

A lower cost option, particularly appropriate with wastewater for use in urban agriculture, is to recycle only “gray water” – drainage water other than that from the toilet – as this eliminates most of the disease vectors. With modest adaptations, urine can also be cheaply and safely used for irrigation (Johansson et al., 2003). On the other hand, there are also some negative effects of long-term use of recycled water. Based on research in Israel, soil water repellency tends to increase and the aquifers exhibit high levels of nitrates and pesticides (Wiel-Shafran et al., 2005, 2006); salts also tend to increase with repeated recycling. Some analysts now believe that only water that has received tertiary treatment should be recycled for crops.

Apart from long-term effects, the least understood aspects of water recycling and reuse are not the technology, nor the methods to ensure that farm workers are protected and crops are safe to eat. Rather, they concern the institutions to manage wastewater, and to develop markets for reclaimed water. Major questions remain to be explored about where to locate such agencies (part of, or independent from, water supply agencies), how to price wastewater, and how to control use (Abu and Maher, 2004; Brooks et al., forthcoming).

2.5. INDIRECT OR VIRTUAL WATER

Very little water as such moves in commerce. Despite the ubiquitous plastic bottle, the total volume of water shipped in plastic is really quite small. Even adding beer and soft drinks does not amount to a lot of water. In contrast, vast quantities of water move internationally in the form of agricultural and Industrial products. To the extent that these commodities require water for their growth

[6]All references to IDRC Water Demand Management Forums can be found at www.idrc.ca/wadimena

or production, shipment implies indirect transfer of what has been called "virtual water" (Allan, 2003). When citrus fruit from MENA is shipped to North America, water is being moved from a water-deficient to a water-surplus area. (Worse yet, because citrus fruit require relatively clean water, high-quality water is being lost). The reverse occurs when grains are shipped from North America to MENA, and this is by far the larger flow. The flow of virtual water into the Middle East as grain imports every year has been estimated to equal the flow of the Nile (Allan, 2003).

3. Water Quantity: Economic Stress

Each of the states of the Arabian Peninsula consumes more water than its annual renewable supply, as are Israel, Jordan, and Libya. Egypt, Syria, and Sudan are fast approaching the same situation. MENA as a whole is already using three-fifths of its total renewable supply regardless of cost (Raskin et al., 1996). All of these countries are in trouble; their water use is unsustainable, which implies that current patterns of economic growth and social development are unsustainable.

To some degree, the chronic stress stemming from limited supplies of fresh water can be relieved by new sources of supply, which is the conventional approach. Since Roman times, and no doubt earlier, engineering works have been constructed to bring water to thirsty cities, and to ensure that enough water is available to grow the crops needed in the cities as well as to provide a surplus for export. Remnants of these works are still visible in ruins of huge aqueducts, and less visible but equally impressive near-surface tunnels (called qanats in the eastern Mediterranean; *fogara* in Iran). Their legacy exists today as megaprojects – Egypt's Aswan Dam, Israel's National Water Carrier, Turkey's GAP (South Anatolia Project), Libya's Great Man-Made River, etc.

This supply-focused approach for fresh water has, for the most part, been successful until now. However, it is reaching its economic limits. A decade ago, the cost (per cubic metre of new supply) was said to be doubling every 10–15 years (Serageldin, 1995). Desalinated water is a partial exception, but transporttation adds significantly to the full cost of supply, and, as indicated above, it is an option only for urban uses, which is not the main problem.

The quantity problem for fresh water is therefore mainly an economic problem, and the principal way to relieve this stress is through demand management, not supply management. In order to demonstrate this conclusion, it will first be necessary to review the ways in which water is used in MENA, and then look at ways in which water use can be reduced without limiting economic growth or endangering human health.

3.1. MAIN USES OF WATER

Water use can be broadly divided into five categories: household, municipal, industry, agriculture, and ecological. Municipal use includes the water delivered to commercial and institutional buildings and hotels (mostly for the same purposes as in households), and to the water used for urban gardens, street cleaning, fire fighting, etc. Ecological use refers to the amount of water that must be left in place to support fisheries, tourism, and hydropower, as well as to protect habitat and provide storage and sanitation. Rough proportions of water use across the region range as follow, with the more urbanized nations using a higher proportion for household and municipal uses and a lower proportion for agriculture.

Sector of Use	Percentage
Households	3–20
Municipal	3–10
Industrial	l–10
Agriculture	60–90 (includes recycled water)
Ecological	Variable

A surprisingly small proportion of water needs to meet drinking water standards. At 5–7 L per person-day (L/p-d), only about 2 MCM per year is needed for every 1 million inhabitants, which is not very much water. Adding enough water for cooking, cleaning, and bathing only increases the requirement to 50 L/p-d (Gleick, 2000), or about 20 MCM per year for a city of 1 million. In contrast, typical irrigation practices in MENA use 10,000 m^3 per year for every hectare, or the same 20 MCM for only 20 km^2 of farmland. Industry is also a relatively small user of water across the region, though some industrial operations cause such high levels of pollution as to effectively consume more water than is indicated in the statistics. The major user throughout MENA is, of course, agriculture. If anything, the data understate the proportion of water that goes to agriculture because they miss local use from springs and hand-dug (shallow) wells. Becker and Zeitouni (1998) expressed the overwhelming importance of this sector in a different way: “The water crisis between Israel and the Palestinians is really a water for agricultural use crisis.”

The other large sector of “use” is the one about which we know least. We are coming to realize how much water must be left *in situ* to protect ecological values (Postel and Thompson, 2005). Already we know, for example, that the excessive extraction of water from the Lower Jordan River, mainly for agriculture in Israel and Jordan, results in net economic losses in both nations (Katz et al., 2004). Techniques are now available to estimate the volume of water needed to maintain a healthy ecosystem (Postel and Richter, 2003; Smakhtin et al., 2004). We also know that, in dam-controlled rivers, water should be released in patterns that emulate, as closely as possible, natural cycles. Fortunately, desert plants and animals have adapted to wild fluctuations in flow rates so that, ironically, they are more resilient than rivers in temperate climates. Nevertheless, the volume of water required to satisfy ecological demands for water is so large as to suggest that supply-focused water management is reaching not only economic but also environmental limits.

3.2. CONSERVATION AND EFFICIENCY IN THE USE OF WATER

Conservation of water, including both increases in efficiency with existing uses and changing patterns of use (Brooks, 2006), has always been a major consideration in the water-short Middle East. However, the fact that a region is short of water does not mean either that existing use is efficient or that the pattern of use is appropriate. Many factors, including capital barriers, ill-designed policies, underpricing of water, lack of information, and habits and traditions intervene. It was not really until the 1990s that water demand management (WDM) began to attract serious attention in most MENA nations. (Israel was a bit "ahead of the curve" with its development of drip irrigation, but only for that one sector).

Much of the work on WDM from the past 10–15 years was brought together in the International Water Demand Management Conference in Jordan in the summer of 2004 (www.mwi.gov.jo/IWDMCP/index/MON.htm), the first conference of its kind ever to be held in the region. In the 2 years prior to that conference, Canada's International Development Research Centre (IDRC), together with several other donor agencies, had sponsored regional workshops on WDM designed to bring together researchers and policy-makers to discuss aspects of WDM that are particularly relevant in MENA.[7] A booklet that reviews the forum process has also been prepared (Baroudy et al., 2005) as has an article on key conclusions (Brooks et al., forthcoming). The most striking conclusion from this last article is that, after a decade of work:

> *From a government perspective, the main objective for WDM efforts in MENA is to cut budgetary costs, not to save water or to make water-use more efficient or equitable.* Effects on water use were generally assumed but rarely demonstrated and, even less often, quantified. Little attempt was made to establish linkages to poverty reduction and environmental protection. …however much emphasis is placed on water management in

[7]Materials, including country case studies, were reproduced in Arabic, English, and French, and are available at www.idrc.ca/wadimena website (click on "WDM Forums").

> MENA, a targeted focus on water *demand* management remains to be fully developed. (emphasis in original)

Individuals, private firms, and public bodies must begin to look at reductions in the use of water as if it were a source of supply. In many ways lower demand is better than greater supply because it occurs at the point of use and thus avoids pumping costs and delivery losses. Reducing demand is also the most effective way to improve security, minimize risk, and avoid environmental damage. Without changing use patterns and relying only on off-the-shelf technologies, water savings typically exceed 25% and in some cases reach 50% (Vickers, 2001; Gleick et al., 2003). Just plugging the holes in the very leaky urban system of Tunis, which is not atypical of cities in MENA, is reported to have a benefit–cost ratio of 5:1, as reported in the Tunisian drinking water case study at the IDRC Forums on public–private partnerships (IDRC).

3.3. ECONOMIC INCENTIVES

Effective programs to promote WDM include multiple components – information, education, demonstrations, pricing, and other economic incentives. However, it is widely accepted that economic incentives are a necessary condition. The first step in any program for WDM is to install water metres. Regrettably, only a few governments in MENA do a good job at measuring the volume and timing of water use. The second step is moving gradually to charging water users for the full cost, if not the full value, of the water they use. Despite what has commonly been stated in the West, the consensus of Moslem scholars is that Islamic law does not forbid charging for water deliveries under normal conditions (Faruqui et al., 2001).

Though almost all MENA governments provide water at very low or no cost to the poorest economic cohorts in society (see further below), none questions the basic principle of pricing water. However, with but few exceptions, and then only for urban households, do users pay the full costs of water supply. This gap between cost and price works against greater water use efficiency. Despite what is commonly said, it does appear that water use is significantly responsive to price, particularly in higher income households and in buildings and factories. Price elasticity (the ratio between the proportionate drop in consumption and the proportionate increase in price) was measured at 1:1 in Tunisia (Tunisia drinking water case study; IRDC). Similarly, as prices for irrigation water were gradually raised, farmers shifted to higher value crops, notably vegetables and fruit trees, and away from cereals.

It is sometimes alleged that the “social tariffs” (called “lifeline rates” in North America), which provide cheap water to poor people, and which are mandated as much by religion as by politics, work against greater water-use efficiency. It is hard to accept this allegation. For one thing, as indicated above, the amount of water required for basic household use is quite small; for another, when coupled with increasing block rates for those who use more than the minimum quantity of water each month, the water utility will collect enough revenue to cover the subsidy required for the social tariff. Finally, whatever the government may lose through the social tariff is likely "repaid" in a healthier population.

Though increasing block rates (water prices that increase with the volume of use) are generally both efficient and equitable, exceptions can occur. They can penalize an extended family living under one roof and using water from a single metered connection, even though they are part of the lowest income cohort in society.[8] There are few if any firm rules in water pricing, and certainly no one best tariff structure.

What water agencies really need in MENA nations is smarter pricing, not just higher prices. There are a range of conservation-oriented pricing schemes that have been tested and shown to provide simultaneously human equity, reduced or deferred capital expenditures, and higher *in situ* flows for environmental protection (Just et al., 1999; Wang et al., 2005). Such schemes can be designed specifically to provide greater resilience in times of drought.

Although gains are possible in all sectors, the sheer dominance of irrigation in the region means that agriculture demands special attention. Every country provides water to farmers at moderately to heavily subsidized prices. Jordanian farmers in the valley get water at 1 or 2 cents per cubic metre, and Egyptian farmers along the Nile do not pay anything. (Both must, however, work within time or volume allocations). Facing growing shortages and competing demands from urban dwellers, Israeli scientists developed drip irrigation, which has raised water-use efficiency to 90% (only 10% of the water is lost to infiltration or leakage) and been largely responsible for a drop of 40–60% in water use per hectare. However, drip irrigation is capital-intensive, and it is not appropriate for all crops. Lower cost systems have been developed, and are gradually diffusing throughout the region (Postel et al., 2001).

Some of the water that is lost from apparently inefficient irrigation on an upstream farm is returned to a watercourse, and thus either becomes available to farmers downstream or serves to recharge aquifers (Seckler, 1996). However, natural recycling is never complete – a share of the water is lost to evaporation or to deeper aquifers, and quality declines as sediment and residues are carried in the runoff. Moreover, the extent of such natural recycling varies with the

[8] I thank Dr Asit Biswas of the Third World Centre for Water Management for this observation. He has observed this phenomenon in Colombo, Sri Lanka.

geology and geomorphology of the river basin. The Nile in Egypt is notable for the large amount of natural recycling, and Egypt has plans to use artificial drains to enhance drainage from one field to another.

The key question about the use of water for agriculture in MENA is not whether water is used efficiently in irrigation but whether irrigation is an efficient use of water (intersectoral rather than intrasectoral shifts). In most cases in MENA, national economies would be stronger and the total value of output greater if water were transferred from agriculture to industrial or municipal uses. In a few countries, such as Palestine, the opposite is true; their economies would be stronger if water could be transferred into agriculture (Lonergan and Brooks, 1994; Becker and Zeitouni, 1998). However, despite the apparent appeal of simply raising prices of irrigation water to reflect marginal costs and forcing farmers to become more efficient or quit farming, such policies have to be carefully considered. Farming is culturally and socially embedded in MENA, and experience elsewhere suggests that measurable economic gains in one sector can be offset by (typically unmeasurable) losses elsewhere. Certainly forcing farm families into overcrowded (and water-short) cities is unlikely to be sound policy. Just as in urban areas, the key for irrigation is smarter pricing, not just higher prices (Dinar and Mody, 2004). One area that does require immediate attention is the lack of government control over extraction of groundwater, which in much of MENA is unmeasured and unpriced.

The ultimate answer to the current excessive use of MENA's water in the agricultural sector is a return toward rainfed methods – not just traditional farming but adaptations that are guided by modern knowledge and that focus on food quality as well as food quantity (Falkenmark, 2004). No other region of the world is so dependent upon irrigation as is MENA (Falkenmark and Rockström, 2005), so even a partial shift will have huge consequences. The shift will depend on more understanding and better of use of what is coming to be called "green water," the water (more accurately, water vapor) contained in soil, as opposed to "blue water," the water in rivers and aquifers. Remarkably, there is roughly twice as much green water as blue, and it is on this water that increases in food production will mainly depend. As Falkenmark and Rockström put it (2005):

> Rain is the global water resource. How well we capture and manage it will determine if we can feed the planet's 9 billion inhabitants by 2050.

3.4. DEALING WITH TOUGH CASES

One approach for analysis of water demand options in MENA is to select the difficult cases, those nations that are most severely constrained by growing populations on the one hand and limited (and degraded) water supplies on the other. Jordan, Tunisia, Yemen, and the Gaza Strip, will all be in a difficult situation, even with the best management of their water. How should they proceed, given their particular histories, economies, cultures, and hydrogeological characteristics? Relevant material exists, as with Al-Kharabsheh and Ta'any (2005) on Jordan, Matoussi (1999) on Tunisia, Abutaleb (2002) on Yemen, and Bruins et al. (1991) on Gaza. For the most part, the recommendations involve strong action by government to rationalize the water sector and to control both additional withdrawals of water and casual runoff and to promote high rates of water recycling. Egypt is considerably better off than these nations in terms of per capita water availability, but her population is so large that the scale of the required shifts is so large that, from a sociopolitical perspective, she may in effect be the most water-constrained nation in MENA.

Analyses of future options for water-stressed nations must of course go beyond the water sector (Allan, 2003; Brichieri-Columbi, 2004). Much more efficient and equitable use of water is essential, but, at some point, problems with water must be regarded as a symptom rather than result. It is necessary to look outside the water sector and consider political institutions and socioeconomic policies. Inevitably, some of the options will be highly political. No matter how efficient in water use these nations may become, there is a positive relationship between water use, on the one hand, and population, economic growth, and the extent of irrigated agriculture, on the other. Those issues will have to be considered, and sooner rather than later. Because, the power elite in those societies will be affected, it will take great political courage to move toward any form of sustainable and equitable economic development. However, if it can be achieved, the water sector should become a contributing rather than a limiting factor.

4. Water Quality: Ecological Stress

Water quality, the second component of the regional water crisis in MENA, is less ancient but increasingly pressing. It is almost as important to conserve the quality of water as to conserve its quantity. Once degraded, it is expensive to restore surface water to its original quality, and all but impossible to restore the quality of underground water. Some analysts believe that, around the world, the costs of water restoration are underestimated by a factor of ten or more (Falkenmark, 2005).

Most water quality problems in MENA derive from one of three factors: overpumping from aquifers, agricultural runoff, and inadequate sewage collection and treatment. Industrial water pollution is relatively low across the region, but there are some shocking exceptions. For example, industrial water pollution is inexcusably bad around Gabes in Tunisia, at Israeli plants located just across the Green Line in Palestine, and near olive oil mills and food processing plants throughout the region.

In other respects, water quality problems in MENA are similar to those elsewhere in the world, and, unhappily, the slow and still very inadequate attention to those problems also reflects the situation elsewhere in the world. No MENA nation has an environmental protection agency with much power to act against water pollution. Other economic interests, many of them concentrated in powerful government departments and backed by segments of the power structure, block action against even the most egregious forms of water pollution. The situation is best documented in Israel, where the long history of environmental neglect has recently been described in a remarkable book by Alon Tal, the founder of the Israel Union for Environmental Defense.

4.1. OVERPUMPING OF AQUIFERS

Pumping of groundwater at a rate that exceeds natural recharge causes a decline in the water table, and is called "mining" of water because it treats water as a nonrenewable resource. ("Mining" is of course inevitable with fossil aquifers). In many countries of the region, water tables are falling by 10–100 cm per year, which lowers pressure and adds to pumping costs. The lower pressure, in turn, permits other, generally lower quality, water to flow inward and contaminate the aquifer. For example, many Mediterranean countries have coastal aquifers that lie a few metres above sea level, which creates an outward pressure that blocks the inflow of seawater. However, when heavy pumping continues for decades, it lowers the freshwater level so far that sea water from the Mediterranean can now be found 1–3 km inland. As one unhappy result, most residents of the Gaza Strip drink well water that exceeds World Health Organization standards for salt content. In some places, aquifers have been drained to the extent that it is no longer worth pumping from them at all; the water is too badly contaminated even for agricultural use. The water quality problem has become so severe that it now contributes to the water quantity problem. It is possible to recharge depleted aquifers with clean water, but this is an expensive and uncertain process.

4.2. AGRICULTURAL RUNOFF

Agricultural runoff is the major nonpoint source of water pollution in MENA, and includes sediment, phosphorous, nitrogen, and pesticides. Per hectare use of pesticides and fertilizer in the region rates among the highest in the world, and runoff is correspondingly high. For example, over the past two decades, nitrate concentrations in the Coastal Aquifer underlying Israel and Gaza (from both fertilizers and reuse of sewage effluent) have doubled. For another, Al-Sin Lake in Syria, the main coastal source of fresh water, is heavily polluted by runoff. Such problems are anything but inevitable. Conservation tillage, contour planting, terracing and filter systems, among other methods, can control soil erosion and reduce phosphorous and nitrogen runoff by up to 60%. However, most MENA nations are reluctant to impose the kinds of regulations that the situation requires. Export markets for fruit and vegetables are highly competitive, and the higher costs that runoff controls would impose would have adverse commercial effects. The only major force for change are the growing import restrictions in Europe that ban imports of produce that have residues of pesticides and other contaminants.

4.3. URBAN WASTEWATER

Even though cities in MENA long ago recognized the need to provide fresh water and to remove wastewater, their water supply and sewage systems are typically old and have either begun to deteriorate or to fail because of the growing loads placed on them. Generally, larger urban areas in MENA have water supply and sanitation systems that are adequate, if barely so. Smaller cities and rural areas lag far behind. However, leakage rates in cities typically reach and even exceed 40%, large enough to impose economic costs on the utility and environmental costs on the population. There is no reason why losses could not be cut below 15%. Jordan and Morocco have forced firms operating their urban water systems to focus on leak reduction, with the value of saved water exceeding repair costs by factors of five to one. Israel has accomplished the same by transferring responsibility for urban water systems to the municipal governments and then imposing fines keyed to rates of leakage.

4.4. HABITAT LOSS

Water quality in MENA is also being seriously degraded by losses of natural habitat as a result of decisions to drain swamps, canalize rivers, or expand urban or agricultural land. Reclamation of land to expand urban space in Bahrain has not only destroyed commercial fishing grounds but also blocked natural drainage of agricultural land and increased the salinity of groundwater. Drainage of the Hula swamps in northern Israel resulted in faster runoff and heavier pollution loads downstream.

Water *in place* has value and delivers a wide range of values to society (Millennium Development Assessment, 2005; Postel and Thompson, 2005). Some aspects of this value have been noted above where reference was made to an ecological sector of demand. Some of these values, as with fisheries and hydropower, can be measured in conventional economic terms. Other values are partially calculable, as with recreation and tourism. The King Talal reservoir is too polluted for recreational use, but, as the only standing body of water in Jordan, this pollution has a high opportunity cost. As a result of extracting 90% of the water that used to flow into the Dead Sea, Israeli hotels on the relatively flat western shore of the Dead Sea that used to lie close to the water are now half a kilometre inland. Highways have to be relocated to avoid fractures and sinkholes as the limey layers dry out and begin to erode.

Finally, water in place supports values that are difficult to capture in economic terms, as with regulation of river flows, ecological balance, habitat protection, flow stabilization, and the sheer beauty of natural sites. Not even religious values can stem the use of nature as a depository for waste. Christian pilgrims who come to one of the possible baptism sites and bathe in the lower Jordan are likely unaware how badly polluted is the water in which they immerse themselves. Habitat loss is severe across all but the most arid parts of MENA, and those losses are particularly severe for wetlands. Today, many MENA nations are adopting the western approach of protecting some blocks of land in national parks and game reserves. Israel did amend its 1959 water law to recognize nature as a beneficial use of water and to require annual reports on the amount and quality of water allocated for ecosystem purposes. Jordan, Morocco, Tunisia, and Turkey have all adjusted water management projects to protect nature reserves or increase flows into lakes and wetlands. Generally, however, MENA nations score well down in global rankings of the ecological protection afforded to their water bodies, and they continue to ignore evidence that well-maintained ecosystems support economic values for society that are much higher than the private values obtained after conversion to supposedly more productive uses (Postel and Richter, 2003; Millennium Development Assessment, 2005).

5. Equity: Political Stress

Water, not oil, has historically been at the heart of political conflict for the peoples of MENA. These conflicts are managed at three levels: first, the internal and highly centralized agencies that have responsibility for national water management; second, the internal, and in some cases traditional systems, for local water management; and, third, the international institutions that have emerged to manage conflicts between nations. This section will review these agencies and institutions and then conclude with attention to two “hot button” topics: privatization of water systems and water wars.

Non-governmental organizations (NGOs) also play a significant role in water management. For example, the Palestine Hydrology Group is effectively responsible for rural water management in Palestine, and Friends of the Earth Middle East (Palestine, Jordan, Israel) brings together paired communities that are on opposite sides of a border but share a water body to act jointly for actions from government. NGOs have also played a great role in support of participatory irrigation management.

It is also worth noting that MENA gains from the presence of numerous high-quality research institutions that put a significant portion of their resources into the analysis of water problems and opportunities. Some of these institutions are international, as with the International Centre for Research in Dry Areas in Aleppo, Syria; others are national as with Institut Agronomique and Veterinaire Hassan II in Rabat, Morocco; and still others are independent, as with the Applied Research Institute – Jerusalem in Bethlehem, Palestine.

The NGOs and the research institutes in MENA represent a huge body of intellectual capital and practical experience in water management. In some cases, as with programs for WDM, they may have better information than government agencies. However, the very diversity among them in goals, size, and modes of operation is so great as to block any generalization.

5.1. INTERNAL CENTRAL AGENCIES

MENA nations are characterized by some of the largest and most sophisticated water management agencies in the world. Even in ancient times, it was centralized systems (operating, admittedly, with lots of slave labor) that built the *qanats* that brought water from the mountains to cities such as Palmyra, and that developed extensive irrigation systems that covered riverine ecosystems. Still today, these water agencies remain oriented to large-scale, centralized supply (dams, reservoirs, and other engineering works), with the result that both smaller scale, decentralized supply options and demand management tend to be neglected. Inevitably but necessarily, other key ministries, such as health and industry, also want to assert their interests. Water is critical to so many aspects of life that it is naive to expect that any one agency can play an exclusive role in setting policy. Thus, even in MENA those central water agencies must share formal power with other parts of government.

Many national water management agencies in MENA (as elsewhere in the world) suffer from conflicting objectives. They are supposed to build and maintain infrastructure, and at the same time deliver water at low prices. Many public water utilities are trapped in a vicious circle of unbalanced budgets, poor service to customers, and a refusal of customers to pay bills. Some nations sensibly have separate agencies for irrigation water and for drinking water, but they fail to provide guidelines as to how the two should collaborate or coordinate their efforts. Frank judgments of senior officers from those agencies who participated in the IDRC Forum on Public–Private Partnerships included such words as *mismanaged*, *obsolete*, *outdated*, *anarchic*, and *unmotivated*. The same officials were somewhat less critical of the quasi-independent agencies that manage specific regions, as with the Jordan Valley Authority (Jordan) and the Litani River Authority (Lebanon). However, apart from general recognition of the virtues of centralizing policy and decentralizing operations, views on appropriate institutional design vary widely. It is not clear which tasks should or should not be assigned to the central agency, nor where agencies for WDM should be placed and, probably more important, where they should rank in bureaucratic hierarchies. Issues such as traditional practices, gender concerns, and environmental impacts are only rarely considered as part of water management.

There is no one best way to organize for WDM, but some existing results are suggestive (Brooks et al., forthcoming). Results appear to be better when responsibility for wastewater disposal is located within the same agency as the one for freshwater supply. Building in some degree of independence from central government also seems to help. Management contracts with a mixed public–private firm to deliver water to Amman, and concessions to private firms for a range of urban services in some cities in Morocco, seem to be working well, but the extent to which this experience can be generalized is open to question. Institutional analysis is badly needed to determine what is conducive to success (or to failure) at both policy and operational levels for specific areas of WDM.

5.2. INTERNAL LOCAL INSTITUTIONS

From an historical perspective, water management in MENA has always had both centralized and decentralized components. What is new is the neglect of the latter in the post-World War II era of economic development when governments (commonly in collaboration with donor agencies) concluded that modern irrigation management was just too complex for peasant farmers. Later, when top-down management commonly failed to achieve its objectives, the same governments and donors rediscovered the benefits of local water management.

Local institutions developed from the bottom-up occur almost everywhere in MENA that one finds a spring or a well (unless it is a really big one). No matter what formal method of allocation may be prescribed by government agencies, some local institution, reflecting its own sense of equity, will typically be exerting authority – and being respected. Typically, some family or clan will control the supply, and it will therefore favor members of that "in-group" – but not to the total exclusion of others. Trottier (1999) has elucidated the complex ways in which springs and wells are managed in the West Bank, irrespective of the rules established by either the Government of Israel or the Palestine Water Authority.

Local institutions developed from top-down processes go by a variety of names, as with Water Users Associations (WUAs) or Collective Interest Groups (GIC in French). As shown decisively at the IDRC Forum on Participatory Irrigation Management, results are almost always better than when government agencies direct operations (Attia, 2003): Water-use efficiency typically goes up by 30–50%; energy use for pumping is cut in half; and collection of fees can be enough to cover operating costs. Such gains may not, however, yield an absolute saving of water. Commonly, they mean that tailenders on the water system now get water regularly where they did not before. *In lower income nations, WDM is as much about equity as about efficiency*. Other benefits include a reduction in conflict and a sense of empowerment that is said to improve family health and well being (Slama, 2003; Brooks et al., forthcoming).

Many lessons can be drawn from recent experience with decentralizing water management. Success will come most easily with traditional irrigation systems and homogeneous communities, less easily in mixed communities that are moving toward larger and more commercial systems. Experience with farmer management is most common with tertiary (distribution) canals; only now are experiments under way at secondary (feeder) canals. Perhaps most important, decentralization of water management does not happen by itself. As stated by Van Hofwegen (2003), the whole approach implies a shift in emphasis "from infrastructure investment-based projects to institutional development – investment projects, thus, become structural components of longer-term programs."

Finally, internal equity is an issue in all MENA nations. Few water systems are managed in so ethical a way as to avoid bias against the poor, or against some ethnic group. Israel offers one example that can be cited only because of a vigorous NGO movement. Over some 99% of the Israeli population receives clean water through pipelines. In contrast, around 60,000 Israeli Bedouins living in informal communities ("unrecognized villages"), exist without running water. Similar examples can be found throughout rural areas of MENA. Many such cases originated in the bureaucratic tendency to neglect groups that lack power. However, when those cases persist through time, one has to charge that the neglect has become policy. Evidence is strong that the poor, and indeed all marginalized groups, get full rights to water only when programs are explicitly oriented to their benefit (Van Koppen, 1999; Klawitter and Qazzaz, 2005).

5.3. INTERNATIONAL INSTITUTIONS

Some 25 major international rivers occur in MENA. No comparable tabulation exists for aquifers, but there are many: the Disi Aquifer underlies Jordan and Saudi Arabia, and the Mountain Aquifer underlies Israel and Palestine. The basic principle for sharing water remains "equitable utilization," a deliberately vague phrase that implies that the ways to share specific bodies of water must be negotiated to fit the physical, economic, social, and historical context appropriate to the parties to the dispute. Prior notification of changes, and avoidance of downstream harm are corollary principles. Fischhendler (2007) maintains that, in many cases, ambiguity is deliberately built into water sharing agreements or treaties to allow for flexibility in operation and to prevent disagreements over specific issues from blocking agreement for continued cooperation. Even so, in the absence of rules, the rights of parties to specific quantities of water at specific times of the year remain contentious.

Discussions about international waters, including those in the Middle East, typically conclude with a call for basin-wide or aquifer-wide commissions to manage them as a unit. Such schemes are visionary, or at best premature. There is simply too little trust among these nations to consider joint management. It has taken the USA and Canada a century to become comfortable with joint procedures for management of their shared boundary waters, and almost as long for the Netherlands and Belgium to learn how to manage the aquifer that underlies their border. Some progress is evident on the two huge river basins – the Nile and the Tigris-Euphrates – but to now the notion of true joint management is more potential than reality. Only in areas where it is almost self-evident that joint management is essential to avoid irreparable harm to all – the Dead Sea is a good example (Bromberg, 2004; Katz et al., 2004) – is integrated management likely to be successful in the next few years.

In these circumstances, it might be helpful to shift attention from rights aimed at the supply side to rights to certain levels of demand. Various analysts have suggested figures of 50–125 L/p-d as a basic entitlement or human right. (The larger figure allows for home gardens as well as for household use). Only about 20 L/p-d needs to be potable, but the rest must be clean enough not to carry pathogens. It might also be appropriate to shift attention to from quantity to quality issues. Competing demands for water rights have something of a win–lose character whereas environmental problems commonly affect all parties, and it is therefore possible to look for win–win solutions.

5.4. PRIVATIZATION

In contrast with much of the rest of the world, experience with partial privatization of urban water systems has been relatively successful in MENA. The extent of this privatization, which has been strongly rejected in much of the world, is bounded by two constraints. First, privatization involves only the delivery of water services. The water itself, both surface and underground, remains the property of the state; in some cases the infrastructure is also the property of the state, as is water treatment. Second, privatization takes place almost exclusively in large urban areas. The high costs and wide range of development objectives linked to providing water in rural communities precludes any significant role for private firms. So too do the subsidies for irrigation water that are ubiquitous in MENA. Only in Morocco is there much interest in private sector participation in large-scale irrigation systems (Doukkali, 2005).

Two approaches to privatizing urban water services are found in MENA: First, based on a pattern common in France, urban water systems in several large cities of North Africa are managed through long-term "concessions" awarded on a competitive basis to private firms. (Most concessions include electrical supply and wastewater collection but not treatment). Second, in Jordan, a consortium of private firms and public agencies have a management contract to operate the water system in Amman. Among the key differences between the two is that concessionaires are typically responsible for some new investment and have considerable freedom to set water tariffs, whereas firms with a management contract do not generally invest in the system and water tariffs are set by government. Both must typically meet government-set goals for leak reduction and for installation of water metres.

Though evaluation is far from complete, both approaches seem to be working well, at least in terms of providing good quality water without major disruptions in service, reducing the previously high rates of leakage, and regularizing the previously erratic collection of water tariffs from customers. The key to this success may lie in the fact that, almost uniquely in the developing world, MENA is characterized by strong central governments that have the capability to deal as equals with the private firms engaged in urban water management. They have therefore been able to impose requirements to offer low priced water to the urban poor, to incorporate incentive and penalty clauses, and, where necessary, to cancel the arrangement (as Morocco did for the concession in Rabat). On the other hand, apart from leak reduction, there is little to suggest that the private firms are any stronger in their efforts to promote WDM than public agencies (Brooks et al., forthcoming). Nor, of course, by their very nature can they respond to requests for greater social control of, and social objectives for, fresh water.

5.5. WATER WARS

Over the years, many people have argued that the next war in the Middle East will be over water. Most such statements represented journalistic hyperbole, but some came from high-ranking officials and academics (for example, Bulloch and Darwish, 1993). It is true that, at times, shots have been fired or bombs dropped on water installations. Israel attacked a partially completed dam on the Yarmouk River late in the 1967 war; Iraq destroyed much of Kuwait's desalination capacity before retreating at the end of the Gulf War. However, to go from these examples to a general proposition of water wars ignores the wide range of technical or institutional options to overcome water scarcity. Such approaches can relieve pressure much more cheaply and with much less risk than military conflict (Kliot and Shmueli, 1998; Wolf, 1998, 1999; Dolatyar and Gray, 2000; Postel and Wolf, 2001; Beaumont, 2002; Jägerskog, 2003).

Given this differential in cost, it is not surprising to find a plethora of studies use econometric models to demonstrate not merely that water could be used more efficiently, but that the resulting transfers of water between Israelis and Palestinians would contribute to the peace process (Becker and Zeitouni, 1998; Fisher, 2002, Fisher and Huber-Lee et al., 2005). Of these, the Fisher and Huber-Lee study is the culmination of a long research process and is the most comprehensive in its approach to the subject. Among other things, they point out that no rational person (or nation) will put a higher value on water than the cost of its replacement (by other water or by commodities). Looking at the Israeli–Palestinian conflict in this way, they conclude that the economic value of all the water in dispute is only a few tens of millions to a hundred million dollars per year – rather small sums in national accounts. The *annual* cost for loss of water appears to be comparable to the *daily* cost of modern warfare. In short, it is difficult to argue that, even in this, the most highly water-stressed region of the world, belligerent nations are going to raise the water stakes high enough to go to war. And history bears out this conclusion. As shown by Wolf (1998), putting to one side border conflicts where the border happens to be a water body, there has not been a war over water for several millennia. What does occur in MENA, as elsewhere, is that nations take advantage of power differentials to make economic or political gains. Upstream nations are generally assumed to have greater power, but geographic position is only one factor that determines effective power. The rule does seem to apply to Turkey on the Tigris and Euphrates, but it does not apply to Ethiopia or Uganda on the Nile. More common is the use of military or political power to control access to water. Military domination allows Israel to use more than its share of fresh water shared with Palestine, and Syria has been able to use its political strength to capture most of the sources of the Yarmouk for its own use but to the detriment of Jordan.

The Israeli–Palestinian case is the most prominent dispute over fresh water in the MENA region. It was the subject of direct negotiations through the Water Resources Working Group of the Multilateral Track of the Middle East Peace Process. Nondiplomatic talks and studies on the Mountain Aquifer, the Dead Sea, and other shared resources also contributed to the peace process. However, many of these activities ceased with the onset of the Second Intifada, and resolution of water issues has been deferred to Final Status Negotiations. The result of both diplomatic and nondiplomatic work on water issues has been mixed. Although some progress has been made toward reallocating water to satisfy Palestinian needs, rather less progress is evident on readjusting institutions so that management of water is also shared. That resolution is possible is shown by Annex 2 of the Israel–Jordan Peace Treaty (1994), which is almost a model for how to manage water that flows along, across and under an international border.

The fact that water wars are more the stuff of journalism than analysis should not be taken to imply that fresh water in MENA will be untroubled by conflict. To the contrary, fresh water will be characterized by conflict. However, the conflict will be seen as local tension and as civil disorder within a nation. The major source of struggle in the next few decades will occur between the rapidly growing urban areas of MENA and the existing dominance of water use and water institutions by agricultural interests. Parallel with that conflict will be another between those who want to withdraw more water for the development of commercial activities and those who want to retain the water *in situ* for the protection of environmental values. Those sorts of conflicts can be bitter, but they do not lead to international war (Homer-Dixon, 1999; Chatterji et al., 2002; Jägerskog, 2003; Falkenmark and Rockström, 2004).

6. Conclusion

What the nations of MENA face is not so much a crisis over water as a chronic problem escalating because older problems are deepening at the same time as newer ones appear. With few exceptions, the nations in this region have already reached or are fast approaching the limits of their indigenous water supplies. Though some forces, such as full cost pricing of water, technological advances in rainfed agriculture, and institutional gains to promote integrated watershed management, may mitigate the problems, others such as climate change and higher populations and incomes will exacerbate them.

In order for the peoples of MENA to achieve a sustainable freshwater use, they and their governments must shift from the current emphasis on increasing supply to alternatives for reducing and reallocating demand. Except for those few nations with enough energy to run desalination plants, greater efficiency in water use and wastewater reuse, or shifts of water from one sector to another, are the only big options left. Greater efficiency is only weakly encouraged by existing institutions; the potential gain from intersectoral reallocation is almost totally ignored.

Though there is ample scope for technical research and research dissemination on WDM, technology is not the big problem. Most of the methods and tools have been around for centuries. Nor is economics much of a problem, at least not if economic effects are broadened to include soil degradation, water pollution, and deteriorating human health. Rather, MENA nations need to focus attention on social and cultural impacts, on behavioral and gender aspects, and on the institutions that can creatively manage and accelerate the process of adopting a long-term, demand management focus for water – in the broadest sense of the word, on governance of water management. As was stated in a synthesis of the 2005 World Water Week in Stockholm (SIWI, 2005). "The 1990s witnessed the growth of globalisation, but also that of a governance deficit." With advances in water demand governance, and in particular water demand governance for agriculture, MENA could lead the world in showing how to live securely with limited water resources.

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WATER DEVELOPMENT FOR ISRAEL: CHALLENGES AND OPPORTUNITIES

SINAIA NETANYAHU*
Tahal Consulting Engineers, Ltd.

1. Introduction

The purpose of this paper is to illuminate the challenges and opportunities faced by the Israeli water sector in its transitional journey towards a sustainable water sector.

Israel, like many other countries, is facing the challenging goal of achieving sustainable water development as part of a more comprehensive national plan for sustainable development. This commitment of achieving sustainable water development is subject to issues of integration, often-conflicting targets between economic growth and development, environmental conservation, and social equity.

Satisfying multisectorial objectives presents a great challenge and requests ongoing technological and structural innovations and changes in the water sector. Because it is highly developed, Israel suffers from both the costs and enjoys the benefits associated with a highly urbanized and industrialized economy. For example, highly dense developments of buildings and roads prevent rainfall from naturally recharging into aquifers and thus reducing the country's potential water reserve. Also, vast traditional and advanced industry and highly industrialized agricultural sector contribute to pollution of natural water resources. At times, such pollution creates irreversible damage to the country's scarce natural resources. Israel's sophisticated and well-developed economy also contributes to an increasing standards of living and hence to an increasing demands for water quantity and for high water quality and reliability. Dealing with such challenges calls for innovative approaches and solutions. Having an advanced public and private research and development (R&D) sector helps Israel to arrive at technological and economical solutions in the fields of water production and water treatment (i.e. desalination and recycling).

*54 Ibn Gvirol Str., Tel Aviv 64364, Israel

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Another critical aspect of Israel's sustainability project is in the area of water; specifically its water supply obligations towards the Palestinian Authority and the Hashemite Kingdom of Jordan as specified in various peace treaties. The challenge of managing transboundary resources is obviously not limited to water allocation but extend also to dynamic sustainable management of surface and groundwater resources and to prevention of polluting those resources.

As such, while facing increasing gaps between adequate water supply and water demands Israel is continuously adjusting to the arising challenges by attempting multiple avenues for water management.

2. Water Resources

2.1. WATER QUANTITY

2.1.1. Water Supply

The multi-annual average of the natural water supply in Israel for the years 1994/5–2003/4 was 1,840 MCM. This is distributed as follows: Kinneret[1] Basin 659 MCM, Coastal Aquifer 248 MCM, Yarkon-Taninim Aquifer 361 MCM, Western Galilie 140 MCM, Carmel 47 MCM, Eastern Mountain 353 MCM, Negev and Arava 32 MCM. Additional supply is added to the Kinneret (22 MCM) and to the Coastal Aquifer (202 MCM) as a result of artificial recharge that originates mainly from treated sewage (in the Coastal Aquifer). Total input to all sources for the year 2003/4 was 2,085 MCB and total pumping was 1,764 MCM. Total output from the natural water system was 2,187 MCM. Israel also recently began producing some 100 MCM of fresh water via a seawater desalination plant located in Ashkelon. Additional production of desalinated seawater is expected in the next decade.

2.1.2. Water Demand

The total water supplied in Israel for local consumption and for keeping transboundary obligations was 2,054 MCM (Israel Water Commission, 2005).

The three main economic sectors: agriculture, domestic, and industry consume most of Israel's renewable water supply. In the year 2004, total domestic demand for fresh and marginal water was 1,954 MCM: 1,129 MCM for the agricultural sector, 712 MCM from domestic uses (urban needs and residential use), and 113 MCM for industrial purposes. It is interesting to note that the water consumed by the agricultural and by the industrial sectors reached 85% and 75% of the official allocated quantities, respectively. This evidence is not unique to this particular year and it originates from a mix of trends in the market such as economic slow-down and an efficient adoption of the water-pricing mechanism by those two major maximizing profit sectors of the market (for detailed analysis see Just et al., 1999).

Water allocated to neighbouring entities as part of peace agreement was 55.4 MCM for the Hashemite Kingdom of Jordan and 44.36 MCM for the Palestinian Authority.

By law, part of the national water supply must be reserved for nature and for landscape purposes.

Projection into 2010, suggests an increase of approximately 25% in urban water demand relative to the 700 MCM demanded in 2002 and approximately 10% increase in industrial water demand relative to the 99 MCM consumed in 2002. Fresh water to be allocated to the agricultural sector is expected to remain approximately the same and allocation for environmental purposes is expected to double and reach 50 MCM by 2010 (Israel Water Commission, 2002).

A long-term perspective of Israel's water demand suggests a gradual increase in domestic water consumption due to natural growth of the population, immigration, and an increase in the standard of living. Residential and general urban water saving is highly encouraged mainly by regulating the instalment of water-saving devises in new houses and by national campaigns that encourage water-saving use patterns.

In the industrial sector, demand is expected to rise by a relatively small amount.

An interesting development has occurred in the agricultural sector where the share of high-quality fresh water has diminished relative to the total supply and stands at about 50% of the total water demanded by this sector. The share of recycled and other marginal sources of lower quality water has grown.

2.2. WATER QUALITY

2.2.1. Water Supply System

While the quality of drinking water has improved in recent years the quality of water resources in Israel has deteriorated and additional new threats have appeared. In order to satisfy various types of consumers, a careful management of the water supply systems is required. We are concerned not only with the quality of water at the source but also with its quality along the production, treatment, and delivery systems. The major categories of risks and the factors that pollute the water resources are (for further details, see Tahal, 2006):

Interface with the hydrological balance:

- Seawater intrusion to the coastal aquifer as a results of lowered water tables

- Interference with the hydrological balance and saline intrusion
- Lowering the Kinneret water level and saline intrusion
- Entrance of pollutants to the Kinneret as a result of interference with the ecological balance

Environmental risks:

- Urban sewage
- Agricultural pollutants
- Industrial, oil and transportation pollutants

Operational risks:

- Pollution at drilling sites
- Failure in supply systems
- Residuals of water treatment materials
- Degradation of pipelines
- Pollution in supply systems
- Pollution of natural resources originated from irrigation using recycled water

Risks associated with intentional activities:

- Vandalism
- Terror

Risks associated with transboundary pollution
Risks associated with Earthquakes

Appropriate action plans are required for each subject under each category.

Preventing pollution and other risk factors at the source is likely to be the most cost-effective mechanism in the management of water resources. However, real-time monitoring systems must be set along the water supply chain in critical spots from catchments to tap in order to assure appropriate level of water quality for all consumers.

2.2.2. Water Demand

Quality standards for drinking water are set by the Ministry of Health. A reviewing committee is established every 5–10 years to review and to update the standards according to the world's experience and according to Israel's needs.

The latest round of evaluation by such a committee has worked on updating the drinking water standard (2003–2006).

The pattern of demand for water according to quality level in the agricultural sector has changed. Today, the agricultural sector uses a mix of fresh water and recycled water depending on the type of crops, soil, availability, and hydrological sensitivity of the region.

Official water standards for irrigation for the agricultural sector are not yet set. However, since recycled sewage water is now a customary water source, the Israelis government has approved new standards for upgrading the treatment level of sewage water. Also, use of recycled water on agricultural fields is conditioned, among other things, by an approval from the Ministry of Health and the Hydrological Service of the Israeli Water Commission in order to avoid irrigation along sensitive hydrological spots.

Introducing recycled water into the agricultural sector freed up quantities of fresh water and allowed Israel to better deal with other sectorial demands for fresh water and to delay investments in costly seawater desalination plants.

Finally, the overall demand for high-quality water has increased. Standards of drinking water are rising and standards for upgrading treatment of sewage water have been approved. Such improvements are accompanied by large economic investments and successful implantation requires identifying long-term funds, effective financial instruments, and stable cost-sharing mechanisms.

3. Challenges and Opportunities

3.1. GLOBAL CONTEXT

The Brundtland Commission report (WCED, 1987) defined development as sustainable if "it meets the needs of the present without compromising the ability of future generations to meet their own needs."

In 1992, the Rio meeting on sustainable development in reference to water suggested that, "sustainable development is a goal that requires fairness in the use and conservation of water resources between the present and the future generation."

A slightly different, while more comprehensive and challenging definition was suggested by UNESCO (1999): "sustainable water resources systems are those designed and managed to fully contribute to the objectives of society, now and in the future, while maintaining their ecological, environmental, and hydrological integrity".

The challenge of achieving a sustainable water sector is especially large for Israel as its water sector is characterized by:

- Scarce water resources
- Intensive water use
- Large numbers of competing users
- Potential prevention of water supply for future generations at present prices

This perspective suggests a need for advanced management emphasizing quality, quantity, and accessibility assurance within and across sectors and generations.

3.2. LOCAL CONTEXT

The challenges faced by Israel in the water sector is spread over many subjects and require an integrated approach using advanced multidisciplinary abilities. The country's semi-arid climate, scarce water resources, increasing competing demands, and increased level of pollution and degradation of resources suggests that the gap between available suitable water and water demand is growing.

Among the challenges faced by Israel are (listed not in order of importance):

- Prevention of contamination of water resources locally and from across boundaries
- Treatment of already contaminated water resources
- Creating affective monitoring systems from catchment to tap
- Ensuring secure and safe drinking water
- Upgrading sewage treatment in all facilities and building new facilities where needed
- Defining R&D goals for the water sectors and allocating funding for basic and applied research
- Enlarging water supply (by desalination and use of other marginal sources) and lowering its production cost.
- Adjusting water prices in all sectors in order to reflect scarcity
- Executing and implementing the government's decision regarding the establishment of the "National Authority of water and sewage"

- Increasing clarity regarding the authority of each governmental stakeholder
- Upgrading infrastructure in peripheral areas
- Improving communication between stakeholders in the areas of data exchange and in routine and emergency notification, processes and actions regarding regular scheduled activities and regarding threats to the water supply
- Creating useful indicators for policy-makers for evaluating progress
- Improving upon residential water saving
- Complying with water peace agreements with neighbouring entities

4. Summary

In recent years several close studies have examined the water sector in Israel. Along with academic research and private technological development, activities of the sector and the institutional structure of the sector were examined by capacities such as the state comptroller, a parliamentary investigation committee, the water commission, and the drinking water standards committee.

These studies reflect on the gaps in the water sector but also indicate a very dynamic and advanced sector that deals with multiple sources of risks and large climatic uncertainty by disseminating new technologies of water production, water treatment, and advanced management tools.

The technological advantage and the long experience of Israel in water management in all sectors of the economy can be put to the benefit of regional neighbouring entities and to the international community by exporting knowledge and technology.

The expected establishment of the new National Authority of Water and Sewage provides a unique opportunity for cooperative work among the various governmental offices, non-governmental organizations, the private sector, and citizens.

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WATER AND SECURITY IN JORDAN

SAMER A. TALOZI*
Jordan University of Science and Technology

Abstract: Jordan, an oasis of security in the midst of a tumultuous region, finds itself more every year an oasis of thirst as well. Small in area but large in ambitions for economic growth and development, Jordan is discovering that the most hindering factor for its ambitions is the scarcity of water. Determined to overcome this challenge, the government has embarked on a series of actions, policies, and projects to insure meeting future water needs. Working alongside international agencies, private sector and academic institutions in Jordan, the government has adapted a dual approach in dealing with water scarcity; an approach that not only focuses on water resources planning and management but also edges to water demand management. Nonetheless, pressures and competition over the available water resources are mounting every year. Furthermore, demand management programs are yet to prove effective in a country in which the current water use per capita is already at a minimum compared to healthy standards. Apparently, many challenges lay ahead in the future for Jordan. Will wise planning and integrated management be enough for the future needs or will water scarcity be a menace to Jordan's sense of security?

Keywords: Jordan; surface water; groundwater; strategies; management

1. Introduction

The story of water in Jordan has been told time and again. On every occasion the topic of limited water resources, rising water demands, or aridity is discussed, Jordan, one way or another, finds its ways in the front. Scientists from Jordan and abroad have always found it fascinating to tackle the subject of Jordan's water condition. A country small in area, roughly around 90,000 km^2, but with large ambitions for development, Jordan is rapidly developing on all fronts. A thriving tourist sector; luxury hotels and beach resorts are on the

*Dr. Samer A Talozi, Jordan University of Science & Technology, samerbse@just.edu.jo

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rise in Aqaba, the Dead Sea, and other places. Massive urban developments, characterized by higher living standards than existing, are surfacing in the horizons of Amman, Aqaba, and Zarqa. Add to that an agricultural sector that consumes roughly more than half of the country's available water resources. These are only few examples of mounting pressures on the water resources in Jordan. Currently, each capita receives around 130 L/day of water, which places Jordan as one of the most water scarce countries in the world on a per capita basis. Meeting future water demands is becoming more and more of a real challenge. With a population of 5.3 million and a growth rate of 2.8%, conventional water resources cannot solely face the augmenting demands, thus, utilizing nonconventional water resources and demand management are becoming increasingly needed. Water is the most critical natural constraint on Jordan's economic growth. Current needs are not being met, and the cost of developing the remaining resources are raising rapidly. Presently, the deficits are being covered by mining of groundwater beyond the safe yield, and in some cases by exploiting of nonrenewable groundwater. Development on all fronts, rising population, fewer and more expensive options for the development of new water resources, and water demand management programs in the agricultural and urban sectors that are yet to prove effective in controlling water use all are crafting a formula for future challenges that Jordan will have to cope with. The government, aware of these challenges, has put plans and strategies not only for the planning and management of water resources, but also for the management of water demand as well. A twofold approach that is undeniably needed if Jordan is to meet its future water needs.

2. Climate and Hydrology

Jordan's climate varies widely across its terrain that ranges from 415 m below sea level at the Dead Sea to 1,800 m in the Southern Highlands. Roughly, three main climatic zones can be distinguished across Jordan.

The Jordan Rift Valley is an area characterized with its subtropical climate, mild winters, and very hot summers. The northern parts of the valley receive fairly good rainfall during the rainy season from October to April. Average rainfall in the northern parts of the valley is about 350 mm/year. Around the Dead Sea, average rainfall is about 200 mm/year. The southern parts of the valley, toward the Red Sea, receive less than 50 mm/year.

The Northern and Southern Highlands are areas characterized with rather cool, rainy winters and warm summers. The most favored areas around Ajlun receive more than 600 mm/year of rainfall in average year. In winter, snowfall is not uncommon.

The Eastern and Southern Deserts (Badia) are areas characterized with cool winters and very hot summers and it amounts up to 70% of Jordan's area. Total rainfall in average years is below 100 mm/year, and maximum temperatures may exceed 50°C.

More than 93% of the country's surface area lies under the agronomic aridity limit of 200 mm of rain per year. Evaporation exceeds rainfall for most parts of the year. The transition from the semiarid highlands to the desert is gradual. The "Agro-climatic Zones" classification shown in Table 1 gives a more detailed description of variation in annual rainfall across the different climatic zones.

TABLE 1. Spatial variation of annual rainfall (mm/yr) across the climatic zones in Jordan

Classified zone	Annual rainfall (mm/yr)	Catchment area (km^2)	Area ratio (%)	Rainfall volume (1937–1998) (MCM)
Semihumid	500–600	620	0.7	425
Semiarid	300–500	2,950	3.3	1,170
Marginal	200–300	2,030	2.2	530
Arid	100–200	20,050	22.3	2,950
Desert	<100	64,350	71.5	3,425
	Total	90,000	100.0	8,500

3. Water Supplies

Water supplies in Jordan can be categorized into conventional and unconventional. Groundwater, rivers, streams base flow and flood flow encompass the conventional part, while treated wastewater, brackish and desalinated water are considered unconventional resources. Highly variable seasonal rainfall is the main source of water in Jordan. Significant amounts of rainfall (i.e. above 200 mm/year) are limited to the highlands in the northwestern part of the country. Approximately 5% of the rainwater infiltrates into the ground and replenishes the groundwater aquifers, while the amount that is transformed into direct flood flow is slightly smaller. More than 90% of the annual rainfall is lost to evapotranspiration. In addition to the local water resources, regional watercourses, and transboundary groundwater flow contribute considerably to the country's renewable resources.

Considering the present surface water developments, Jordan's renewable natural water resources including Yarmouk River water are estimated to be in the magnitude of 800–850 MCM/year. Under average annual conditions 275 MCM/year are considered sustainable groundwater abstractions, while 220 MCM/year is the base flow. The remaining volumes are flood flows. Their utilization depends on the availability of sufficient reservoir storage.

TABLE 2. Mean annual water budget

Precipitation	Evapotranspiration	Total runoff	Surface runoff	Groundwater recharge	Unit
8210	7540	670	280	390	MCM/year
92.5	84.9	7.6	3.2	4.4	mm/year
100	91.8	8.2	3.4	4.8	% of precipitation

3.1. SURFACE WATER

Jordan does not possess rivers in the worldwide known scale, except the Jordan River which used to discharge around 1,400 MCM/year into the Dead Sea before the development of the water resources in its catchment. Even this river is a very small source compared with international rivers like the Nile or Euphrates, because its total annual discharge amounts to only 1.5% of the former and 4.3% of the latter. Other surface water resources in Jordan are found in the Yarmouk and Zarqa rivers and in wadis like Karak, Mujib, Hasa, Yabis, and El-Arab.

Water flowing in Jordanian streams maybe a direct runoff from heavy rainfall, base flow leaking out from groundwater bodies, and/or discharges from wastewater treatment plants. Direct runoff in Jordan lasts normally from less than an hour to very few days. This makes it difficult to manage this type of resource. Dams are required for storing the runoff in winter and releasing it as needed during the summer. Beside these ordinary reservoirs, desert dams help increase groundwater recharge and provide water for pastoral use by collecting thunderstorm waters. Water made available from the existing ordinary reservoirs is around 190 MCM for the year 2005 (including flood flow, base flow, and treated wastewater). The reservoirs capturing flood flows are all located in the foothills of the Jordan Rift Valley, on both north and south of the Dead Sea. The safe yield is further increasing over time due to the increase of treated wastewater inflow. The present and planned desert dams are estimated to contribute an additional 20 MCM/year to the replenishment of the aquifers.

TABLE 3. Projected surface water budget in million cubic meters

Year	Base flow excluding reservoir inflow	Reservoirs safe yield (floods, base flow, and treated wastewater)	King Abdullah canal from Yarmouk base flow	Wehdeh dam floods from Yarmouk River	Total
2005	142	188	126	0	456
2010	128	240	126	85	579
2015	128	264	126	85	603
2020	118	292	126	85	621

Following is a description of the major surface water resources in Jordan.

3.1.1. The Jordan River Area

JORDAN RIVER

The surface catchment area of the Jordan River measures 18,194 km², of which 2,833 km² lie upstream of the Lake Tibereas outlet. The eastern catchment area, downstream of Tibereas, measures 13,027 km², and the western, 2,344 km². The headwaters of the Jordan River originate from three main springs: Hasbani in Lebanon, Dan in Israel, and Banias in Syria. The three streams join in Israel to form the Upper Jordan River. The surface catchments of the springs do not alone account for the large quantities of water discharged from them; therefore, their underground watershed must extend further to the north, northeast, and eventually northwest, beyond the surface catchments and into Syria and Lebanon.

The total discharge of the Jordan into the Dead Sea, prior to the implementation of the different water projects in Jordan, Syria, and Israel, was 1,370 MCM/year. This amount has now declined to a mere 250–300 MCM/year mostly as irrigation return flow, intercatchment runoffs or saline spring discharges.

The discharge of the Yarmouk River into the Jordan River was around 400 MCM/year prior to the use of the water by the different riparians. In the last years, this amount has gradually declined to small discharges, only as a result of large floods, which cannot be accommodated by the existing extraction facilities.

YARMOUK RIVER

The Yarmouk River flows at the borders of Syria and Jordan and joins the Jordan River in an area partly occupied by Israel. The river drains both flood and base flows of Jordanian and Syrian territories. The total catchment area of the river measures 6,790 km², of which 1,160 km² lies within Jordan upstream of Adasiya and the rest within Syria and in the Jordan River area downstream of Adasiya. Along its course from the foothills of Jabel Druz to its union with the Jordan River, many important wadies and creaks in terms of water quantities join the Yarmouk like Harir, Allan, and Raqqad in Syria and Shallala and El Humra in Jordan.

The average annual rainfall over the catchment area is 372 mm/year. In the northwestern parts of the catchment, which borders the Hermon mountains, precipitation increases to an average of more than 1,000 mm/year. It decreases to 250 mm in the southeastern corner of the catchment. The discharge of the Yarmouk River in Adasiya during the 1940s, 1950s, and beginning of the 1960s of this century is given in the literature to equal 467 MCM/year. More recent measurements, although masked by unknown usage of the riparians, indicate a decline in the river discharge. The river flow during 1950–1976 averaged 400 MCM/year. Recent measurements of flows and estimates of riparian extractions indicate an average total discharge of around 360 MCM/year.

ZARQA RIVER

The Zarqa River drainage basin, which measures 4,025 km² consists of two main branches; Wadi Dhuleil and Seil – El Zarqa, which drain the eastern part and the western part of the catchment area, respectively. Both branches meet at the town of Sukhna to form the Zarqa River. Naturally, the eastern branch drains only flood flows as a result of precipitation, while the western branch drains flood and base flows. The most densely populated area in Jordan which is the catchment area of Zarqa River comprises around 65% of the country's population and more than 80% of its industries.

The urban wastewaters are generally sewage and treated in different wastewater treatment plants to varying degrees. In addition, most industries located in the catchment area treat their wastewaters before discharge into the surface water system. Several solid waste disposal sites are also located within the catchment area. Their leachates reach surface and groundwater resources causing local pollution and threatening to contaminate the aquifers.

The catchment area of Zarqa River receives an average annual precipitation of 237 mm. The potential evaporation ranges from 1,600 mm/year along the western highlands, to 2000 mm/year in the eastern part of the catchment. Meanwhile, there is not enough water to satisfy the needs of the evaporation force of the climate, which is far less during the winter months than during the summer months, a fact which allows precipitation water to infiltrate and recharge the groundwater during the rainy season.

The average annual discharge of Zarqa River at Deir Alla for the years 1950–1976 was 64.88 MCM/year. After 1976, the natural system of the river was changed by different factors such as construction of the King Talal Dam on the Zarqa River (1977), importing water into the catchment area for domestic and industrial uses and discharging their effluents to the Zarqa River system. Such activities controlled the river flow and increased its discharge on the one hand, and on the other hand negatively affected its water quality.

The King Talal Dam on the Zarqa River was commissioned in 1977 with a total capacity of 56 MCM, which was raised in 1988 to 89 MCM. The natural flow of the Zarqa River cannot fill the dam in an average year. But since increasing amounts of water were imported into the catchment area from other areas to satisfy the increasing demand, effluents reaching the dam are expected to fill it almost yearly.

WADI EL-ARAB

The catchment area of Wadi (Valley) El-Arab measures 267 km^2. The average amount of precipitation ranges from 500 mm over the highlands west of the city of Irbid, to 350 mm in the town of North Shuna in the Jordan Valley. The potential evaporation ranges from 2,000 mm/year in the northwest, to 2,400 mm/year in the southwest of the catchment. The average discharge of the wadi is around 28 MCM/year equally distributed between flood and base flows.

A dam was constructed on Wadi El-Arab in 1987, with a total capacity of 20 MCM to collect flood and base flows for use in irrigation in the Jordan Valley area. Since its completion the dam was filled by waters originating within its catchment, only in the very wet year of 1991/92. In the other years, water was pumped from King Abdallah Canal during floods to increase the stored amount of water in the dam for use during the dry season. The catchment area is agrarian, but Irbid City is expanding westward into the catchment, which may put increasing pressure on the quality of the water collected in the dam.

The wastewater treatment plant for Irbid City was constructed in the upper reaches of Wadi El-Arab. And although the effluent of the treatment plant is piped to bypass the dam, floodwaters still enter the treatment plant and wash its contents and the wastes along Wadi El-Arab into the dam reservoir, negatively affecting its water quality. Drilling of wells and pumping of water upstream of the dam resulted in groundwater level declines and hence the ceasing of groundwater natural discharges. In the last 10 years the drop in the groundwater levels in Wadi El-Arab wells exceeded 25 m, a fact which questions the future reliability and durability of this drinking water source supplying Irbid governorate. The water collected in the dam is generally of good quality and can be used for different purposes. When used for domestic purposes, conventional treatment of filtration and chlorination is sufficient.

WADI ZIQLAB

The catchment area of Wadi Ziqlab measures 106 km². Its eastern parts receive an average amount of precipitation of 500 mm/year, whereas its western parts in the Jordan Valley receive only 300 mm/year. The potential evaporation ranges from 2,050 mm/year in the west to 2,200 mm/year in the east. Various springs issue along Wadi Ziqlab with a total discharge of some 5 MCM/year. In addition Wadi Ziqlab drains another 5 MCM/year of floodwater. A dam was constructed in Wadi Ziqlab with a total capacity of 4.3 MCM in 1966, and its water is used for irrigation in the Jordan Valley area.

WADI SHUEIB

Wadi Shueib drains an area of approximately 180 km² lying to the west of Suweileh region at elevations of 1,200 m down to below sea level. Precipitation over the catchment area partly falls in the form of snow in its eastern parts and ranges on average from 500 mm/year in Suweileh and Salt mountains to 150 mm in the Jordan Valley area.

The potential evaporation ranges from 2,700 mm/year in the eastern parts to 2,500 mm/year in the western parts. The average natural flow of the Wadi is 1.8 MCM/year as flood flow and 3.9 MCM/year as base flow. In addition the effluent of the Salt town wastewater treatment plant, one of the best functioning in Jordan, is discharged into the wadi.

In the catchment area different towns and villages, like Salt, Fuheis and Mahis, discharge their treated and untreated wastes along the wadi and its tributaries. A dam was constructed in Wadi Shueib in 1968 with a capacity of 2.3 MCM and with the aim of using its water for irrigation in the Jordan Valley. In addition to base and flood flows, this dam now receives irrigation return flows and the effluent of the well-functioning Salt town wastewater treatment plant.

WADI KAFRAIN

Wadi Kafrain drains an area west of Amman with an extent of 189 km² lying at elevations ranging from 1,200 m above sea level down to areas lying below sea level in the Jordan Valley. Precipitation in the eastern parts of the catchment, averaging 550 mm/year, may fall in the form of snow, whereas in the western parts the average reaches only 150 mm/year and falls completely in the form of rain.

The potential evaporation ranges from 2,700 mm/year in the eastern parts to 2,400 mm/year in the western parts. The average discharge of Wadi Kafrain is 6.4 MCM/year, consisting of 1.6 MCM/year flood flow and 4.8 MCM/year base flow. In addition, Wadi Sir and Hussein Medical Centre wastewater treatment plants end up in Wadi Kafrain or its tributary wadies. In the catchment area different towns and villages, like Wadi Sir and Naur, discharge their wastes along Wadi Kafrain or its tributaries.

In 1968, a dam was constructed at the entrance of Wadi Kafrain into the Jordan Valley with a capacity of 3.8 MCM. This dam now serves as a storage facility for irrigating downstream lands and for recharging the underlying aquifer. It is now being raised to a capacity of 7 MCM. At present, the dam receives in addition to flood and base flows, irrigation return flows, treated and untreated wastewaters and groundwater discharged from artesian wells drilled into the lower pressurized aquifer. Hence, it receives good quality water from springs and artesian wells, medium quality water of floods mixed with treated and untreated wastewaters and bad quality water from irrigation return flows and wastewater treatment plants.

OTHER WADIES DISCHARGING INTO THE JORDAN VALLEY

These wadies are not dammed and include Yabis, Kufranja, Jurum, Rajib, Hisban, and other small catchments. The rainfall on these areas ranges from 150 mm/year up to 550 mm/year, with potential evaporation rates ranging from 2,100 to 2,700 mm/year. The base flow of these wadies is used in irrigation along their courses and partly at the foothills on the Jordan Valley. Flood flows still reach the Jordan River lower stem.

3.1.2. Dead Sea Wadies

WADI ZARQA MA'IN

The catchment area of Wadi Zarqa Ma'in measures 272 km² and ranges in elevation from 1,000 m above sea level to 400 m below sea level. Precipitation over the catchment falls in the form of rain and ranges from 350 mm/year in the highlands surrounding Madaba City to 100 mm/year at the shores of the Dead Sea. The potential evaporation rates range from 2,900 mm/year in the east to 2,400 mm/year in the west at the shores of the Dead Sea.

Zarqa Ma'in discharges directly into the Dead Sea an average amount of 23 MCM/year, of which only around 3 MCM/year as flood flows and 20 MCM/year as base flow. The base flow consists of thermal water issuing from tens of springs ranging in discharge from seepage size to 150 L/s.

WADI MUJIB (INCLUDING HIDAN)

The catchment area of Wadi Mujib measures 6,596 km². Precipitation over the catchment area ranges from 350 mm/year along the mountain highlands to 100 mm/year at the shores of the Dead Sea. Potential evaporation ranges from 2,450 mm/year at the shores of the Dead Sea to 3,500 mm/year in the eastern part of the catchment.

Wadi Mujib downstream of the confluence of Wadi Hidan discharges an average amount of 83 MCM/year directly into the Dead Sea. Half of the river flow consists of base flow and the other half of flood flows. The lower reaches of the wadi system contribute with an average base flow of around 30 MCM/year of mostly lightly mineralized water issuing from the sandstone aquifer complex. The salinity of some springs resembles those of Zarqa Ma'in, containing around 2,000 mg/L of dissolved salts.

WADI EL-KARAK

The catchment area of Wadi El-Karak measures 190 km² and lies at elevations ranging from 1,000 m above sea level to 400 m below sea level. Average precipitation falling over the catchment area ranges between 350 mm/year in the high mountains and 100 mm/year along the shores of the Dead Sea. The potential evaporation ranges from 2,600 mm/year at the shores of the Dead Sea up to 3,100 mm/year along the highlands.

The catchment of Wadi El-Karak is a moderately inhabited and agrarian area. It includes the city of Karak and numerous towns and villages. Karak City possesses a wastewater treatment plant, the effluent of which discharges into Wadi Karak. As in the case of other Dead Sea, the lower reaches of Wadi El-Karak are rich in springs and water seepage issuing from the sandstone aquifers. The average discharge of Wadi El-Karak is around 18 MCM/year, of which 15 MCM/year issue as base flow. The base flow is generally used in irrigation along the intermediate reaches of the wadi.

WADI AL-HASA

The catchment area of Wadi Al-Hasa lies to the southeast of the Dead Sea, but the water flowing in Wadi Al-Hasa discharges directly into the Dead Sea, hence, it is considered one of the Dead Sea catchment areas and measures 2,520 km² and is the second largest among the Dead Sea catchments after Mujib.

Precipitation over the area ranges from 300 mm/year along the highlands down to 100 mm/year in the Dead Sea area and 50 mm/year over the eastern parts of the catchment. Precipitation over the highlands sometimes falls in the form of snow. The potential evaporation rates range from 2,800 mm/year in the Dead Sea area up to 3,900 mm/year in the eastern parts of the catchment.

The average discharge of Wadi El-Hasa is around 34 MCM/year. Only about 2 MCM/year flow as floods, and the rest consists of groundwater discharges along the lower reaches of the wadi. Like the other catchments of the Dead Sea, the groundwater discharged along the lower reaches consists partly of mineralized thermal water.

3.1.3. Wadi Araba Catchments

Wadi Araba itself is not a base level for either surface or groundwater. The northern part of Wadi Araba discharges into the Dead Sea and the southern one into the Red Sea via the Gulf of Aqaba.

THE NORTHERN WADI ARABA CATCHMENT

The northern Wadi Araba catchment extends for about 100 km from the Dead Sea shore southward, with a width of 25–30 km and a total area of 2,938 km^2. Precipitation falls in the form of rainfall, except on the highlands where it may fall in the form of snow. The average long-term precipitation is 300 mm/year over the mountains and 100 mm/year in Wadi Araba area. The potential evaporation ranges from 2,800 mm/year at the southern shores of the Dead Sea to 3,500 mm/year in the southeastern parts of the catchment.

Different wadies drain the catchment into Wadi Araba. The major ones are Wadi Khuneizir, Wadi Fidan, and Wadi Buweirida, with average discharge of about 4, 5.5, and 3 MCM/year, respectively. The major part of discharge comes from the base flow of the wadies. In addition to the major wadies, numerous small ones drain the area. The overall total discharge of all the northern wadies into Wadi Araba is 26 MCM/year. The flood flows, which reach Wadi Araba infiltrate rapidly into the course-grained alluvium deposits building the bottom of the wadi. They seldom directly reach the Dead Sea. But the infiltrated water flows in a northerly direction to reach the Dead Sea as seepage or submarine springs. The catchment area is sparsely populated. The main centers are Tafilah and Shoubak which are devoid of industries. Agriculture is practiced in the highlands, where rain fed crops are produced along the wadi courses and in Wadi Araba, where the base flows of wadies and pumped groundwater are used for irrigation. The area still possesses a certain potential for developing agriculture and for improving the efficiency of irrigation projects.

THE SOUTHERN WADI ARABA CATCHMENT

The area extends around 75 km north of the Gulf of Aqaba, with a maximum east-west width of 30 km. The total catchment area measures 1,278 km^2 with an average precipitation of 150 mm/year in the northeastern parts and less than 50 mm/year in the southern parts and Aqaba area. The potential evaporation rates range from 3,300 mm/year in the north to 4,100 mm/year in the southern part. The area is barren, with very low population density (less than 1 person/km^2). Also, the type of climate and aridity do not support life and do not allow urbanization.

The total water discharge from the eastern wadies into the area is estimated at 1 MCM/year, indicating the very low potentialities of the area. The contribution of southern Wadi Araba to the Red Sea is around 10 MCM/year. This groundwater originates as an aquifer to aquifer discharge coming from the eastern highlands. At the southern end of Wadi Araba, a few kilometers from the Gulf of Aqaba, a flowless water treatment plant was constructed to serve Aqaba City.

WADI YUTUM CATCHMENT

Wadi Yutum catchment drains an extensive area in southwest Jordan, east of Aqaba into the Red Sea. The extent of the catchment is 4,400 km². Precipitation over the area falls in the form of rainfall and ranges from 150 mm/year in the highlands to less than 50 mm/year. In the central and eastern parts of the catchment area, the potential evaporation is very high and ranges from 3,400 mm/year in the western parts up to 3,800 mm/year in the eastern and southern parts. Since the area is flat, precipitation water infiltrates into the barren rocks, mostly consisting of sandstones and weathered rocks. There are no groundwater discharges in the area, and the surface water forms as floods resulting from intense precipitation. But even that is a very small amount of 1.5 MCM/year compared with the extent of the catchment area.

JAFR BASIN CATCHMENT

Jafr basin is an exitless depression in southern Jordan, with a catchment area of 12,200 km². The average precipitation ranges from 200 mm/year at the foot of the highlands to 30 mm/year in the middle and eastern parts of the catchment. The potential evaporation ranges from 3,300 mm/year in the western parts of the catchment to 4,000 mm/year in the center of the depression.

The total discharge of the catchment is around 15 MCM/year, of which 10 MCM/year flow as floods into the Jafr depression, where it either evaporates or infiltrates into the ground. The base flow, in the form of spring discharge, is totally used in irrigation.

The catchment area is very sparsely populated, with Ma'an and Shoubak as major urban centers. Agriculture has been developed along the foothills of the mountains in the west by extracting groundwater. The main industry in the area is a cement factory located in the northwestern edge of the catchment.

AZRAQ BASIN CATCHMENT

The Azraq basin is an exitless depression in the eastern plateau of Jordan. The bottom of the basin lies at an altitude of 500 m above sea level. The drainage basin measures 11,600 km² and extends in the north beyond the borders of Jordan.

Precipitation falls in the form of rain and ranges from 300 mm/year over Jabel Druz southern slopes to less than 50 mm/year in the Azraq depression itself. The average precipitation over the area is 90 mm/year. Potential evaporation ranges from 3,300 mm/year in the northern parts of the catchment to 4,000 mm/year in the central and eastern parts.

The total discharge into the basin is around 27 MCM/year, of which 15 MCM/year issue as groundwater from different springs in the Azraq Oasis itself. Surface water comes as floods from wadies pouring into the depression as a result of precipitation events over the catchment. Few dispersed urban centers and industries are found in the catchment area.

HAMMAD BASIN CATCHMENT

Hammad basin is a very large, flat plateau extending in four countries: Jordan, Syria, Iraq, and Saudi Arabia. In Jordan, the area measures 19,270 km^2. Precipitation over the area ranges from 150 to 50 mm/year, with potential evaporation rates of 3,800 mm/year. Since the area is flat, different surface water collection sites (playas) developed. As a result of precipitation, during the rainy season hundreds of flat areas fill with up to 2 m of water, which either evaporate or infiltrate to the underlying aquifers and flow very slowly to ultimate base levels like Sirhan depression, the Dead Sea, or the Euphrates area. What remains in the playas after evaporation are salty silts waiting for the next flood. The amount of surface runoff is relatively small and averages 5 MCM/year, whereas the groundwater, which forms in the area, averages around 10 MCM/year.

3.2. GROUNDWATER SUPPLIES

The prevalent part of the country consists of bedrock aquifers, which are the main groundwater sources. The most important aquifers are the carbonate aquifers called locally B2/A7 and B4/B5, the basalt aquifer and the sandstone aquifers like the Ram sandstone aquifer or Disi aquifer, and the Kurnub aquifer. Groundwater supplies are replenished, or recharged by rainfall. From the total rainfall only a small part seeps to groundwater. Groundwater budget is shown in Table 4.

TABLE 4. Annual budget of renewable groundwater

Water budget components	Quantity in MCM/year
Groundwater recharge from rainfall	390
Transboundary from Syria	80
Return flows (irrigation, pipes leaks, reservoirs, and treatment plants)	70
Total inflow	540
Groundwater abstraction (wells, springs)	440
Base flow	220
Total outflow	660
Change in storage (deficit)	–120

Besides renewable resources Jordan possesses limited resources of fossil (nonrenewable) groundwater. The yield of this resource is estimated to be about 125 MCM/year, originating from the Rum Aquifer in Disi area. Like other groundwater it can be abstracted and exploited, but unlike other groundwater it can be used for a limited time according to extraction program set for this purpose. This source was replenished many thousands years ago, at a time when climate of the area was colder and wetter than at present. As seen in Table 4, groundwater in Jordan is in continuous deficit which affect negatively on groundwater table and water quality hence salinity is in progressive increase with different rates depending on magnitude of deficit.

3.2.1. Groundwater Aquifers

The groundwater aquifers of Jordan are divided into three main complexes, namely: the deep sandstone aquifer complex, the upper cretaceous aquifer complex, and the shallow aquifer complex.

The Deep Sandstone Aquifer Complex forms one unit in southern Jordan. To the north, gradually thick limestones and marls separate it into two aquifer systems which, nonetheless, remain hydraulically interconnected. These are the Disi group, and the Kurnub and Zarqa group aquifers. The Disi group is the oldest, and in the north, the deepest water bearing sediment sequence in Jordan consisting of sandstones and quartzites. It crops out only in the southern part of Jordan and along Wadi Araba–Dead Sea Rift Valley. It underlies the entire area of Jordan. The southern part of the complex forms the freshwater aquifer of the upper Wadi Yutum–Disi–Mudawwara area. The main flow of the groundwater in this system is directed toward the northeast. Only in the southern parts a groundwater divide in the Rum area separates a small southern region where the groundwater moves toward the west and south. The Kurnub and Zarqa group of Jurassic-Lower Cretaceous Age is also a sandstone aquifer underlying the area of Jordan and overlying the Disi group aquifer. It crops out along the lower Zarqa River basin and along the escarpment of the Dead Sea, Wadi Araba, and Disi region. Wells drilled in this fine-grained sandstone aquifer have fairly good yields. Direct recharge, however, is limited to small outcrop areas. The groundwater in this aquifer, aside from the recharge areas, is mineralized. The Kurnub–Zarqa aquifer system is being exploited mainly in the lower Zarqa River catchment and in the Baq'a areas.

The Upper Cretaceous Hydraulic Complex consists of an alternating sequence of limestones, dolomites, marlstones, and chert beds. The total thickness in central Jordan is about 700 m. The limestone and dolomite units form excellent aquifers. The lower portions of this sequence (A1/2), consisting of about

200 m of marls and limestone, possess in some areas relatively high permeabilities and forms a potential aquifer. An aquitard (A3) consisting of about 80 m of marl and shale overlies the A1/2 and separates it from the overlying A4 aquifer. The latter consists of pure semicrystalline karstic limestones and hence it has very high permeability and porosity. The A4 aquifer crops out along the highlands and is recharged there. To the east this aquifer is confined by the overlying aquitard consisting of marls and limestones (A5/6). The A5/6 aquitard is overlain by the most important aquifer of the sequence; namely the Massive Silicified Sandy Units A7-B2, which consists of limestones, chert-limestones, sandy limestones, and marly limestones. It crops out along the highland and is being recharged there. To the east, like the A4 aquifer, it goes over in a confined aquifer, overlain by layers of marls. The whole aquifer complex is overlain in the eastern desert by a thick marly layer (B3), forming a competent confining bed. Therefore, in some locations, flowing artesian wells are drilled into this aquifer.

The Shallow Aquifers Hydraulic Complex consists of two main systems, namely: the Basalt Aquifer and the Sedimentary Rocks and Alluvial Deposits Aquifer. The Basalt Aquifer extends from the Syrian Jabel Druz area southward to the Azraq and Wadi Dhuleil region, forming a good aquifer of significant hydrogeological importance. The recharge to this aquifer system is provided by precipitation in the elevated area of Jabel Druz. From there the groundwater moves radially to all directions. Geological structures favored the formation of three main discharge zones namely, the upper Yarmouk River basin, the Wadi Zarqa basin, and the Azraq basin. The sedimentary rocks and alluvial deposits of Tertiary and Quaternary Ages form local aquifers overlying partly the previously mentioned aquifer complexes or are separated from them by aquitards. They are distributed all over the country, but are mainly concentrated in the eastern desert, Wadi Araba–Jordan Valley, Jafr basin, and the Yarmouk River area.

3.2.2. Groundwater Basins

Groundwater basins are areas which separated and defined to include appropriate and regionally important aquifer systems. In most basins more than one aquifer complex is present. The National Water Master Plan of Jordan defined the groundwater basins in Jordan as the following:

1. Yarmouk basin
2. Northern escarpment to the Jordan Valley
3. Jordan Valley floor
4. Zarqa basin

5. Central escarpment to the Dead Sea
6. West Bank
7. Escarpment to Wadi Araba
8. Red Sea basin
9. Jafr basin
10. Azraq basin
11. Sirhan basin
12. Wadi Hammad basin
13. Disi–Mudawwara

1. Groundwater in the Yarmouk basin and the northern part of the Jordan Valley escarpment

The groundwater in the Yarmouk basin is found in the B2/A7 aquifer at depths of less than 200 m in the highlands. The groundwater flow is directed toward the Jordan Valley area. Present day artificial extractions of 73 MCM/year indicate that the aquifer is being overpumped by around 56 MCM/year. The National Water Master Plan of Jordan calculates the renewable groundwater amount to be 23 MCM/year. The quality of the water in the unconfined portion of the aquifer is suitable for the different uses. In the confined portion of the aquifer higher temperatures and pressures result in the dissolution of minerals, this adds more salts to the water.

Southern Part of the Jordan Valley Escarpment: The groundwater in this area is found in two aquifer systems; the Upper Cretaceous limestone system and the Lower Cretaceous sandstone system. The general groundwater flow is directed toward the Jordan Valley and discharges there, either as springs or seepages, or flows laterally to the lower lying areas and enters the recent deposits occupying the Jordan Valley floor. Recharge to the aquifers takes place along the highlands of Amman and Balqa (Salt) area.

The amount of available, renewable groundwater, which does not appear as base flow is estimated at 10 MCM/year. The Lower lying aquifer, the Kurnub sandstone contains confined mineralized water. Wells drilled in Kafrain, Rama, and Wadi Hisban areas produce artesian water with salinities up to a few thousand parts per million.

2. Jordan Valley Floor Area

The aquifer along the Jordan Valley floor consists of alluvial fans and other recent sediments interfingering with the salty, clayey deposits of the ancestors of the Dead Sea. The groundwater flow is directed from the mountain foothills to the Jordan River course. Recharge to this area takes place through lateral flows from aquifers extending to the east of the mountain foothills. Some direct infiltration takes place from precipitation water over the area where soil profiles are thin and rocks are porous and permeable.

Deep groundwater mainly in the Lower Cretaceous aquifer is salty and under artesian conditions, and it seeps upward through the recent sediments to the surface, forming saline springs (Wadi Mallaha). The amount of available groundwater in this area ranges from 18 to 20 MCM/year. The water quality in the northern Jordan Valley area is generally good and suitable for irrigation; in certain parts it is even suitable for drinking purposes. To the south, the water salinity increases due to the presence of saline formations and due to irrigation return flows. In certain parts there the water salinity goes up to a few ten thousand parts per million (Wadi Mallaha).

3. Amman–Zarqa Area

Two main aquifers underline this area, namely, the deep A4 and the shallow complex consisting of B2/A7 or A7 along or B2/A7 together with wadi fills and basalts. But the main aquifer consists of the A7 limestones. As in the "Surface Water" section, the Amman–Zarqa area can be divided into two parts; an eastern part extending to the northeast of Wadi Zarqa and a western part extending to the west of Wadi Zarqa. This division is important because of the different groundwater flow systems prevailing in the area. Wadi Zarqa and Zarqa River form the effluent stream of the area's groundwater. Groundwater originating in the eastern part flows in a westerly direction, and that origination in the western highlands of Amman and its surroundings flows in an easterly direction. At the longitude of the Zarqa River, in its south-north course, both groundwater currents converge and discharge in the form of springs.

The renewable groundwater amounts in the area average 88 MCM/year. Around 35 MCM/year return to the surface as base flow along the Zarqa River, and the remaining 53 are pumped through wells distributed over the basin. Overpumping is already taking place along Wadi Zarqa and in the eastern part of the area, such as in Dhuleil and Khalidiya subareas.

Recharge to the eastern parts of the area comes from precipitation falling over that area and partly from Jabel Druz. Floodwaters flowing within the area contribute to the groundwater recharge. Irrigation activities, especially in Dhuleil area, result in irrigation return flows, which infiltrate back to the groundwater body underlying the entire area. Recharge to the western part takes place along the highlands of Amman and its surroundings and along the wadi courses which discharge floodwater. Return flows of domestic water used in houses and for commercial purposes form a nonnegligible part of recharge.

In the Amman–Zarqa area, leaking water supply networks and sewerage systems contribute also to the groundwater stock of the area. Irrigation, industrial and domestic return flows contributions to the groundwater amount to about 40

MCM/year. Industrial effluent infiltration can be estimated at 5 MCM/year, whereas domestic cesspools leak around 25 MCM/year, and irrigation return flows contribute an average of around 10 MCM/year.

The natural water system of the Amman–Zarqa area is now highly disturbed by pumping water into the area. An annual average of about 65 MCM/year is brought into the area from outside and used there. This fact is continuously bringing the water system of the area out of balance. In some parts of the area; along Wadi Dhuleil for example, a rise in the groundwater levels is registered since 1985, whereas in Dhuleil area the contrary is taking place. This is because of the infiltration of semitreated wastewater in the first case and overpumping in the latter. Both badly reflect on the groundwater quality.

For Amman–Rusaifa area it is estimated that 30% of the naturally and artificially discharged water is recycled water, returning from leaking pipes, cesspools and other uncontrolled systems. In Dhuleil area, return flows amount to several million cubic meters per year, which, during the last two decades, have gradually led to aquifer salinization. Along the course of Wadi Dhuleil downstream of Khirbet El Samra, a rise in the groundwater levels of up to 25 m has been registered during the last 10 years, caused by the infiltrating treated and untreated wastewaters from Khirbet El Samra treatment plant, which rendered the groundwater unsuitable for almost all uses including irrigation.

The groundwater qualities in the area represent a complex issue affected by various factors of recharge, discharge, inflows of wastewaters, mixing of different water qualities, leaching of solid wastes, and others. Therefore, no generalization concerning the water quality can be made for the whole catchment.

4. Dead Sea area

This area lies to the east of the Dead Sea and extends some 50 km eastwards. The groundwater is found in two different aquifer complexes; the upper limestone aquifer complex and the lower sandstone aquifer complex. The upper aquifer receives precipitation water, which infiltrates through the soil and rock covers and discharges in short time periods, measured in a few years. It is a renewable source of water. The total available groundwater amounts to around 87 MCM/year. Half of it discharges to the surface through springs along the upper reaches of the of Zarqa Ma'in, Wala, Mujib, Karak, Shaqiq, Ibn Hamad, etc. Groundwater is also artificially extracted from the aquifer through wells along the highlands in the areas of Madaba, Mujib, Katranah, and Karak. It is used for domestic and irrigation purposes. The lower aquifer does not receive any appreciable amounts of direct recharge by precipitation. The water in it originates from other areas.

The water quality allows only for restricted uses like irrigating salt-semitolerant crops. But this thermal water can also be used for therapeutic purposes. Together with the climate prevailing in the area and the Dead Sea water, the thermal spring water issuing from the sandstone aquifer complex represents a potential wealth element for the country.

5. Northern Wadi Araba

The wadi floor is built up of alluvial sediments brought from the surrounding mountains in the east and west with thicknesses of thousands of meters. The water at greater depths is saline due to the effects of the Dead Sea interface and to the geologic history of the area and especially of former extensions of the Dead Sea.

The groundwater flows from the mountains in the east in a westerly direction, with a component toward the north; the Dead Sea. Generally, all the groundwater of this area discharges into the Dead Sea. The throughput of water from this area into the Dead Sea was estimated to be around 22 MCM/year. The freshwater renewable resources amount to some 8–10 MCM/year.

6. Southern Wadi Araba

The wadi floor is composed of alluvial sediments brought from the surrounding mountains in the east and west. The thickness of the sediment fill is measured in kilometers, but the fresh and brackish groundwater is found in the uppermost portions of the aquifer.

The groundwater flow is directed from the north to the Red Sea in the south. Recharge comes from precipitation falling on the surrounding mountains in the east; it infiltrates there in the barren rocks and flows laterally into the fluviatile and alluvial deposits covering the wadi floor. A part of the recharge takes place along the wadi courses of the side and wadi Araba itself. The throughput of the aquifer is calculated to be around 10 MCM/year composed mostly of brackish water.

7. Disi–Mudawwara area

This aquifer system crops out in south Jordan and extends southwards into Saudi Arabia and northwards in the underground of Jordan, where it overlies the Basement Complex, which consists of intrusive igneous rocks functioning as an aquiclude. This sequence of sandstones and shells underlies the entire area of Jordan at different depths, generally increasing in northerly and north-easterly directions. The Disi aquifer consists of medium- to fine-grained sandstones with a total thickness of about 1,000 m. The average precipitation over the area is around 80 mm/year, with an average potential evaporation of 4,000 mm/year.

The groundwater in the Disi area is unconfined and lies at a depth of around 80 m below the surface, whereas in the Mudawwara area, the water is confined and partly artesian. The groundwater flow is directed toward the north and northeast. The average permeability of the aquifer is 1.68×10^{-5} m/s with a gradient of 0.143%. Assuming a flow of 40 km in width and a maximized saturation depth of 1,000 m, the throughput of the aquifer is calculated to be equal to 30.5 MCM/year. This figure could be indicative of average recharge or the total flow as a result of fossil gradient adjustment.

It is generally accepted that the groundwater in Disi–Mudawwara area does not receive major replenishment. Extraction of water increased from 15 MCM/year in 1983 to 85 MCM/year in 1995. The total amount of extraction during this period was around 850 MCM, causing a nonrecoverable drawdown in water levels ranging from 3 to 20 m. This nonrecoverable, irreversible decline is a major warning concerning the persistence of water resources.

8. The Azraq Area

This area forms the northern part of an elongated geological depression known as Sirhan depression. It functions as a base level for both surface and groundwater which collects there to form an oasis. The groundwater in this area is found in different aquifer systems ranging from recent deposits to deep sandstone aquifer complexes.

In the shallow aquifer, the water is renewable. In the intermediate aquifer complex the water is moving, but its main recharge areas lie far away in Jabel Druz and in the highlands of Amman–Madaba–Karak, and Tafilah. Therefore, it has relatively an old age. In the lower sandstone aquifer complex the water also has a relatively old age, not because it was stored in the aquifer for a long time, but because it has, since hundreds to a few thousands of years, been underway from the source areas toward the underground of the Azraq area.

The amount of groundwater available in the shallow aquifer is calculated to be 20–24 MCM/year. Due to overpumping, the water levels in the surroundings of the oasis have, dropped by a few meters, to a few tens of meters which has resulted in ceasing the discharge of springs feeding the oasis, and in increasing groundwater salinities. The water of the basalt aquifer is of a very good quality for different uses.

9. Jafr Area

The main groundwater aquifer in the area is B4 – Formation of the Balqa group, consisting of thin beds of chert, limestones, clays, and marls with a total thickness of 20–25 m. The B2 A7 and the Kurnub and Disi sandstones form the deeper aquifers, which are separated from each other by thick aquitards. The different aquifers are weakly interconnected. The groundwater flow in the B4 aquifer is generally directed from west to east. In the lower aquifers, the groundwater flows in a general northerly direction with components toward the northeast and northwest. The groundwater in the deeper aquifers, represent a support and backbone of other groundwater bodies found northwest and south of Jafr basin. Hence, extracting the water of the deeper aquifers would undermine other resources.

Recharge to the B4 aquifer takes place in the mountainous highlands of Shoubak lying to the west of the Jafr basin. Direct recharge by precipitation is negligible, because the surface area of the playa, where floodwater collects, is covered by very fine sediments, which do not allow for the rapid infiltration of recharge water. The total recharge to the B4 aquifer is around 7 MCM/year. Because of overexploitation, the groundwater resources started to deteriorate in the late 1960s, after only a few years of extraction. The salinity increased rapidly from 600 to 700 mg/L in the early 1960s in the different wells, to values between 700 and 2800 mg/L in the early 1970s.

10. Sirhan and Hamad areas

The groundwater in these areas is found in a shallow aquifer consisting of upper Cretaceous and Tertiary rocks and recent sediments of wadi fills, basalts and alluvial deposits. The estimated available groundwater resources for the Sirhan and Hamad areas are 5–10 MCM/year. The water is generally brackish and needs certain technologies to be made suitable for relevant uses. The salinity of the water ranges from around 1,000 µs/cm up to 4,500 µs/cm. The majority of sources have a salinity of about 2,000 µs/cm.

3.3. NONCONVENTIONAL WATER RESOURCES

3.3.1. Wastewater Generation and Reuse

Treated wastewater is a nonconventional water resource of increasing importance for Jordan's water budget; especially since very few future natural resources can be developed and groundwater abstractions need to be reduced to protect the aquifers. Almost 60% of the country's population is connected to sewer systems. In 2002, a total of 19 treatment plants were in operation, treating about 85 MCM of wastewater. In addition to the present treatment capacity, the construction of 17 new plants until the year 2015 is proposed. All these plants are designed for secondary treatment and should meet the criteria for discharge to streams. This would enable treated effluent to be reused for restricted irrigation.

TABLE 5. Future development of wastewater resources (MCM/year)

Year	2005	2010	2015	2020
Waste inflow to treatment plants	146	181	215	247
Waste effluent of treatment plants	138	170	202	231
Treated wastewater inflow to reservoir	–71	–86	–100	–114
Remaining treated wastewater	67	84	102	–117

3.3.2. Desalination

Desalination allows the utilization of Jordan's brackish groundwater resources. The only limiting factors for desalination are economical constrains, such as high energy and conveyance costs. In the year 2003 there was 27 desalination plants in operation and 7 plants under construction; out of that 23 with a total capacity of 1,000 m^3/h are private owned by farmers for irrigation in the Jordan Valley. Water Authority of Jordan (WAJ) operates four desalination plants for drinking water supply.

Major desalination projects are planned. Brackish water from Wadi Mujib and Wadi Zara Ma'in designed to produce 37 MCM/year drinking water for Amman. In Aqaba sea water desalination is foreseen to contribute 5 MCM/year of drinking water for municipal use.

The used surface water for all purposes amounts to 271.5 MCM (Table 6), which represents 33% of the water use in the year 2000, while groundwater use was 473.5 MCM which represents 57% of the total water used in that year. Volume of treated wastewater used was 72 MCM or an equivalent to 9%.

TABLE 6. Water use in Jordan for the year 2000 in million cubic meters (MCM)

Total	Pastoral	Irrigation	Industrial	Domestic	Source
271.516	6,000	209,670	2,537	53,309	Surface water
162.181	0,000	121,180	2,537	38,464	Jordan Valley
52.845	0,000	38,000	0,000	14,845	Springs
56.490	6,000	50,490	0,000	0,000	Runoff and floods
473.604	1,413	252,300	34,156	185,735	Groundwater
412.001	1,409	204,644	29,586	176,362	Renewable
61.603	0,004	47,656	4,570	9,373	Nonrenewable
72.033	0,000	72,033	0,000	0,000	Treated WW
66.933	0,000	66,933	0,000	0,000	Registered
5.100	0,000	5,100	0,000	0,000	Not registered
817.153	7,413	534,003	36,693	239,044	TOTAL

4. Strategies and Management

Jordan has developed, during the past decade, several documents that define in great detail the country's future goals and strategies in relation to future water use and needs. Of these documents are the Jordan's Water Strategy, Irrigation Policy, Ground Water By-Law, and the National Water Master Plan. The following sections recap these documents.

4.1. JORDAN'S WATER STRATEGY

The water strategy, which establishes water as a national resource, discusses varying topics such as water resource development and management, legislation and institutional setup, shared water resources, public awareness, health standards, and private sector participation.

The strategy accentuates the importance of tapping the full potential of surface water and groundwater resources to the extent permissible by economic feasibility, and by social and environmental impacts. It also emphasizes that wastewater shall not be managed as "waste." Instead, wastewater shall be collected and treated to standards that allow its reuse in unrestricted agriculture and other nondomestic purposes, including groundwater recharge. Marginal quality water and brackish water sources are enlisted by the strategy to support irrigated agriculture. In allocating water resources, the strategy gives the first priority to the basic human needs; as such allocating a modest share of 100 L/capita/day to domestic water supplies. The forecasted water resource developments until the year 2020 are shown in Table 7.

TABLE 7. Forecasted water resources development until the year 2020 (Jordan's Water Strategy, Ministry of Water and Irrigation, Amman, Jordan)

Year	2005	2010	2015	2020
Wastewater for local use	49	67	83	97
Desalinated sea water Aqaba	0	5	5	5
Desalinated brackish water	10	31	40	40
Disi fossil water	83	190	124	126
Peace Treaty	65	90	90	90
Renewable groundwater	387	344	307	275
Surface water	467	594	616	643

The water strategy, in its resource management section, gives priority to the sustainability of use of the previously developed resources including resources mobilized for the irrigated agriculture in the Jordan Valley and other established uses; with special care given to the protection against pollution, quality degradation, and depletion. In addition, it places tight checks and controls on mining of renewable groundwater aquifers to reach sustainable extraction rates. Management of wastewater and industrial wastewater with due regard to public health standards and the quality of the effluent of wastewater treatment plants receives great attention from the strategy as well.

Pertaining to legislation and institutional setup, the strategy endorses the update of legislation whenever necessary to respond to the emerging needs including the needs for improving performance efficiency. Additionally, the strategy calls for the introduction and enhancement of the participation of stake holders, and calls for legislating for their involvement wherever necessary.

With regards to shared water resources, the strategy underlines bilateral and multilateral contacts, negotiations and agreements as the means to defend and protect the rightful water shares of the Kingdom. Peace water and wastewater projects, including the scheme for the development of the Jordan Rift Valley, are accorded special attention for construction, operation, and maintenance. Due respect is given by the strategy to the provisions of international law as applicable to water sharing, protection, and conservation, and those applicable to territorial waters. Bilateral and multilateral cooperation with neighboring states is encouraged, and regional cooperation is advocated, preferably within the provisions of a Regional Water Charter.

With reference to public awareness, the strategy promotes the notion of facing challenges in the water sector not only by the water administration, but also equally by the public; along with that the roles in water conservation to be played by the different sectors of society are defined and assigned. To aide in this endeavor, facts about water in Jordan are disseminated along with the cost incurred to provide the service, and the mounting pressure of population on the water resources.

Targeting the recovery of the cost of utilities and the provision of services is a target set by the strategy, while recovery of operation and maintenance costs is standardized. Giving the strategy a social imprint, cost recovery is linked to the average per capita share of the GDP and its level. It is also connected to the cost of living and the family basket of consumption. While, profitable activities in industry, tourism, commerce, and agriculture are expected pay the fair water cost. With regards to large-scale development projects, project financing is to depend on concessionary loans, private borrowing and/or BOO and BOT arrangements; this is until the cost recovery is full, and the national savings are at levels capable of domestic financing of such projects.

The water strategy additionally emphasized several other aspects such as the appraisal of performance of water systems and that of human resources, setting and enforcing national health standards, expanding and encouraging the participation of the private sector, encouraging and enhancing indigenous water research targeted at the improvement of resource management, enhancing the understanding resource economics, and adapting the research findings in other environments to local conditions, including but not limited to, crop water requirements, minimizing evaporation and controlling evapotranspiration and the like.

4.2. THE IRRIGATION POLICY

More than half of the available water resources of Jordan are consumed by irrigated agricultural. Thus, it is obvious that an irrigation policy be set up and that was the case in 2002. The irrigation policy detailed the long-term objectives of irrigation water such as the issues of resource development: agricultural use, resource management, the imperative of technology transfer, water quality, efficiency, cost recovery, management and other issues; but it did not extend to issues of irrigated agriculture. Linkages with energy and the environment are accorded a separate chapter of the irrigation policy. This policy is designed to be compatible with the Water Strategy and is in conformity with its long-term objectives.

One of the most interesting sections of the policy is the section on sustainability of irrigated agriculture. It accords the chances for sustainability for existing areas of irrigated agriculture; affirms that no diversion of its waters to other uses is allowed without providing a replacement source fit for agricultural use unrestricted by health and public health considerations and unduly hampered by chemical constraints; This section in all probability leads the way to the replacement of freshwater resources currently used for irrigation by treated and marginal water resources in the future. Highlighting the increasing significance wastewater is attaining, the irrigation policy again reiterates what has been stated in the water strategy with regards to considering wastewater as a resource and not as "waste." However, sustainability of irrigated agriculture is conditional. The policy makes it clear that this sustainability shall be compromised if it threatens the sustainability of use of groundwater resources. Adding that potential pollution of underlying aquifers or the depletion thereof are among the reasons that can prompt such compromise.

The Jordan River basin, home to the fertile Jordan Valley, is where most irrigated agriculture is concentrated, has shared water resources with the neighboring countries Israel and Syria. Thus, the irrigation water policy gives priority to the development and management of shared water resources. It also promotes the establishment of joint water committees to cooperate with neighboring countries over issues affecting other riparians. In addition, the policy stresses the importance of will be proposing, promoting, and sustaining regional cooperation with neighboring countries with whom Jordan shares international waters.

GROUNDWATER BY-LAW

The groundwater by-law is one of the most comprehensive discussions of groundwater regulations. It outlines in great detail and diligence all the rules and regulations related to the extraction and use of groundwater. Groundwater is highly valued as it appears throughout this document. Its use for irrigation purposes is tightly controlled. The law clearly gives a little edge for some sectors over the rest. Drilling of wells is prohibited in some areas, but the industrial, educational, and tourist sectors are exempt from this prohibition if there is no way to meet their water needs from surface water. Agriculture is not exempt. In an attempt to prevent random drilling of wells for the purpose of irrigation, drilling of wells in a farming area less than a 100 dunums is also prohibited. In addition, groundwater prices are set in this by-law. An increasing block pricing system is used as seen in Table 8, which applies to licensed wells.

TABLE 8. The prices of water extracted annually from licensed agricultural wells

No.	Water quantity	Water price
1	0–150,000 m^3	Free
2	151–200 m^3	25 Fils/m^3
3	>200,000 m^3	60 Fils/m^3

Prices of groundwater extracted annually from active unlicensed agricultural wells are higher as seen in Table 9.

TABLE 9. The prices of water extracted annually from active unlicensed agricultural wells

No.	Water quantity	Water price
1	0–100,000 m^3	25 Fils/m^3
2	101–150,000 m^3	30 Fils/m^3
3	151–200,000 m^3	35 Fils/m^3
4	>200,000 m^3	70 Fils/m^3

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WATER AND SECURITY FOR PALESTINE

The water crisis in the Palestinian Territories: challenges and opportunities for development

ALICE GRAY AND JANE HILAL
Applied Research Institute, Jerusalem

Abstract: The Palestinian territories (PT) suffer from one of the worst water shortages of all the countries in the Middle East, and have one of the most underdeveloped water sectors. All major water resources used by Palestinians are shared with Israel, and utilization of resources, maintenance of infrastructure and development are constrained by the military occupation. Currently, Palestinian water rights in the West Bank have been recognized by Israel, but not quantified, resulting in a lack of sovereignty over resources and difficulty in developing adequate supplies and infrastructure. In Gaza, overpopulation has led to demand outstripping supply. Overabstraction of the aquifer is leading to severe degradation of the resource, and water quality is extremely poor. If no remedial action is taken, the situation can be expected to deteriorate further, with dire humanitarian and environmental consequences. Permanent damage may be done to the sustainable potential of the water resources of the region, to the detriment of both the Palestinian and the Israeli populations. Thus the need for cooperative water management is high, whereas political tension, which frequently explodes into violence, is hampering attempts to implement water management schemes.

Keywords: Palestinian territories; water resources; water rights; sustainable potential; overabstraction; cooperative water management; development

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1. Background

The fates of Israel and the Palestinian territories (PT) are inextricably linked with regards to sustainable water management, as they share the same major natural water resources. These are the Jordan River and the Mountain Aquifer in the West Bank, and the Coastal Aquifer in Gaza. Whilst both parties recognize a deepening water crisis in the region due to unsustainable utilization of resources, Palestine suffers severely from water shortage due to inequitable allocation of resources. Water supply in Palestine must be increased, not only to allow economic development and meet projected population growth, but also to meet the basic needs of the existing population. Due to the fact that all of the natural resources in the region are already utilized up to, and in some cases over, their full sustainable potential, the only options for increasing water supply are through negotiation with Israel, development of unconventional resources (i.e. desalination of brackish water and seawater), or import of water from a third party. Increases in abstraction from natural resources by Palestinians must be met by equal or greater decreases in abstraction by Israelis if resources are not to be overdrawn, causing potentially permanent damage to water quality and sustainable yield.

Since 1967, when the PT came under military occupation, the majority of control over water resources in the area has been with Israel. Shortly after the beginning of the occupation, a series of military orders declared all water resources to be Israeli State property, granted full control over them to the military authority, established a permit system for the drilling of wells and fixed pumping quotas on existing wells (Israeli Military Orders No. 2, 92, 158, and 291). All Palestinian pumping stations on the Jordan River were destroyed during the 1967 war and since that time, Palestinians have been denied any access to this resource. Hence today, all water utilized by Palestinians in the West Bank is drawn from the Mountain Aquifer, which is subdivided into three drainage basins (Western, Eastern, and Northern); whilst in Gaza all water comes from the Coastal Aquifer underlying the Gaza Strip, which is sometimes called the Gaza Aquifer (see Figure 1).

Due to the tight system of control over water resources that was in place from the 1960s to the early 1990s, Palestinians were prevented from developing water resources in the West Bank. Only 23 permits were issued for digging new wells between 1967 and 1990, and 20 of these were for domestic use only. In fact, the number of working wells decreased during this period from 413 to around 300 due to the prohibition on rehabilitating wells without a permit; and also due to the digging of deeper wells by the Israeli water company, Mekorot, which caused many shallow Palestinian wells to dry up (Nasser, 2003).

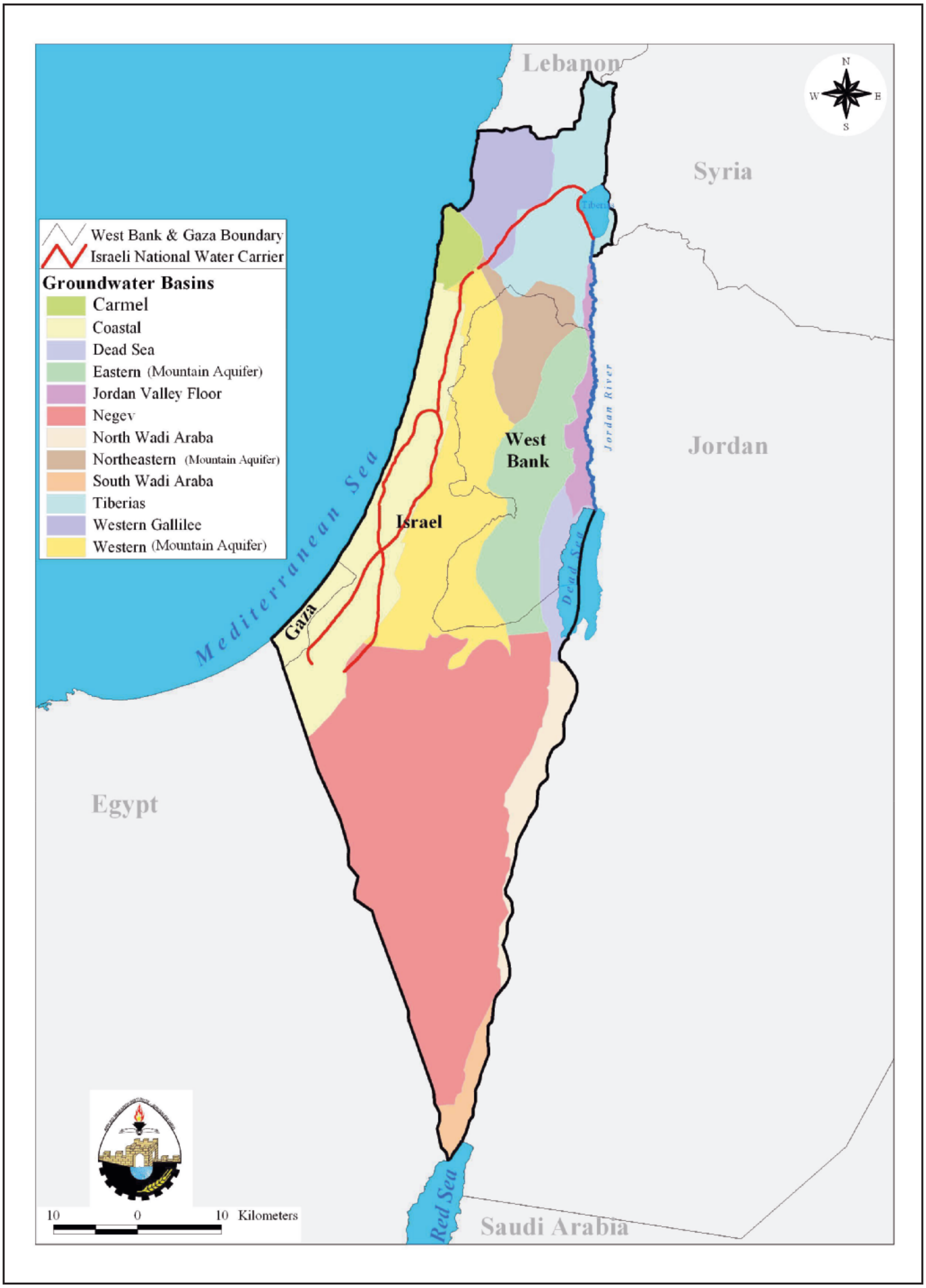

Figure 1. Overview of Palestinian water resources. (Adapted from Applied Research Institute Jerusalem).

Control over the water resources in the West Bank is strategically very important to Israel, as even before 1967, Israel was heavily reliant on the Mountain Aquifer for a large part of the country's water supply, and utilization has expanded since then. Currently, Israel utilizes approximately 483 MCM per year from this source, accounting for around 25% of the country's water supply. In addition, Israel is the "downstream" user of the Mountain Aquifer, and hence Israeli water supplies are affected by Palestinian activities in the West Bank.

This is not the case in Gaza. Although the Gaza Aquifer is contiguous with the Coastal Aquifer in Israel, Gaza is the downstream user. Hence there was no necessity to impose the same kind of rigid controls, and development of supplies and infrastructure were much less restricted. However, Gaza faces a different set of problems due to overpopulation of the area. The total area of the Gaza Strip is less than 400 km^2, but the population approaches 1.5 million people, making it one of the most densely populated areas on earth. Over half the population of Gaza are refugees, many of whom were displaced in 1948, during the formation of the state of Israel. By 1967, the number of wells in Gaza was approximately 1,200 (Nasser, 2003), pumping 65 MCM water per year, which is approximately the natural replenishment rate of the aquifer (WRAP, 1994). By 1993, as the population had expanded, so too had water use. There were 2,100 registered wells and an estimated 900 unregistered wells extracting between 100 and 110 MCM water per year, a figure well above the aquifer's sustainable yield (WRAP, 1994). This has resulted in seawater infiltration and lateral inflow of natural saline water from Israel, causing severe degradation of water quality. Currently only 10% of the water used in Gaza meets World Health Organization (WHO) drinking water standards for chloride concentration of 250 mg/L or less, whilst the chloride concentration in several areas exceeds 1,000 mg/L (Weinthal et al., 2005).

In the 1990s, the Oslo Peace Accords resulted in the formation of the Palestinian Authority (PA), and at the same time, some sovereignty over water resources was granted to the Palestinians. In 1994, the Gaza–Jericho Agreement ceded control over the water resources of Gaza and Jericho to the PA to "operate, manage and develop," with the exception of existing water installations supplying Israeli settlements. The Palestinian Water Authority (PWA) was formed soon afterwards to manage and develop water resources in Palestine.

In 1995, the Oslo Interim Agreements (also known as the Oslo II Agreement) made temporary dispensations about division of the Mountain Aquifer waters between Israel and the PT. Article 40 of the agreement stated that Israel "recognizes the Palestinian water rights in the West Bank" but that "these will be negotiated in the Permanent Status Agreement relating to the various water resources." In the meantime, it was agreed that "existing quantities of utilization" were to be maintained (Table 1), although the Palestinians were to be allowed to develop an additional 70–80 MCM per year from the Eastern Aquifer and "other agreed sources in the West Bank." Essentially, this resulted in approximately 80% of the Mountain Aquifer water being allocated to Israel, whilst 20% was allotted to the Palestinians.

TABLE 1. Extraction and utilization of Mountain Aquifer waters. (According to Annex III, Appendix I, Article 40 of the Israeli–Palestinian Interim Agreement, September 1995. All figures represent MCM water per year.)

	Israeli Share			Palestinian Share			Total	To be developed
Aquifers	Wells	Springs	Total	Wells	Springs	Total		
Eastern	40	0	40	24	30	54	94	78
Northern	103		103	25	17	42	145	0
Western	340	0	340	20	2	22	362	0
Total	483		483	69	49	118	601	78

A Joint Water Committee (JWC) was established to coordinate the development of water resources and infrastructure in the West Bank during the interim period, and Joint Supervision and Enforcement Teams (JSETs) were set up to monitor water resources.

Since the Final Status Negotiations have not yet been concluded, the Oslo Interim Agreements still govern water utilization in the West Bank. This is in fact highly problematic, as the amount of water allocated to the Palestinians is not enough to cover the basic needs of the current population, let alone to allow for population growth or economic development. There is little capacity to develop unconventional resources in the West Bank, which has no coastline; and the potential to import water is limited by the economic capacity of the PA to pay for it. Furthermore, there is considerable doubt about the sustainable yield of the Eastern Aquifer, which may well have been overestimated. Thus it may never be possible to develop the additional 70–80 MCM per year stipulated in the agreement (Selby, 2003).

Therefore one of the most urgent challenges facing the Palestinian administration is to negotiate a new water agreement with Israel that will allow the basic needs of the population in the West Bank to be met, whilst also providing an alternative water resource to Gaza, lifting pressure on the aquifer, and preventing further degradation of the resource.

2. The Current Water Situation in the West Bank

2.1. WATER RESOURCES

In 2005 there were around 288 wells under Palestinian control in the West Bank, extracting a total of approximately 57.6 MCM water per year (PCBS, 2004; PWA, 2005). Of these, 248 are agricultural wells, which are predominantly privately owned, and 40 are domestic wells. Of the domestic wells, 27 are municipally owned; 5 belong to the Jerusalem Water Undertaking (JWU), a subregional water utility in the Ramallah area; and 8 are newly dug wells in the south of the West Bank, belonging to the PWA. There are also approximately 300 springs in the West Bank, of which 112 discharge fresh water amounting to about 60 MCM per year (Jayyousi, 2003). Of this, around 49 MCM is used for irrigation and 5.2 MCM for municipal and domestic purposes.

TABLE 2. Water resources in the West Bank, and annual abstraction from them. (Compiled from PWA, 2005: Quantities of Water Supply in the West Bank Governorates, and PCBS 2004.)

Water Source	Owner	Number	Annual Yield (MCM)
Agricultural well	Private*	248	30.1
Domestic well	Municipalities	27	17.2
Domestic well	JWU	5	2.6
Domestic well	PWA	8	7.7
Irrigation spring	Various	96	49
Domestic spring	Various	16	5.2
Subtotal	Palestinian control	-	111.4
Domestic well	WBWD	10	10.1
Domestic well	Mekorot	38	56.9
Subtotal	Israeli control	-	67
Total			178.4

*A few agricultural wells are owned by cooperatives.

In addition to these there are ten wells which are supervised directly by the West Bank Water Department (WBWD) although they are ultimately controlled and administered by Mekorot (the Israeli water company). These belong to a group of 13 wells that were confiscated by the military occupation in 1978, 3 of which have recently been taken out of operation. The current annual yield of this group is 10.1 MCM water (PWA, 2005), which is automatically allotted to the Palestinians. There are also 38 functioning Mekorot wells which yield about 56.9 MCM water per year (PWA, 2003). The majority of water from these wells is used to supply Israeli settlements in the West Bank. Thus the total annual abstraction from Israeli controlled wells in the West Bank is approximately 67 MCM. Water from these sources, as well as from other Israeli controlled water supplies outside the Green Line may be purchased by the PA, and subsequently distributed by the WBWD.

2.2. WATER SUPPLY

Water use for agricultural purposes accounts for approximately 70% of total water consumption from Palestinian controlled wells and springs in the West Bank, and 53% of total water use (including water purchased from Israeli sources). Irrigated land, which is predominantly in the Jericho area, accounts for only 6% of the total cultivated area in the West Bank; however the productivity of this land contributes 53% to the total agricultural production of the West Bank (Jayyousi, 2003).

Around 69% of Palestinian communities, accounting for 87% of the population, are connected to the water network, although in many cases coverage is partial and deficits are made up by purchasing tanker water or relying on rainwater collection. Only 46% of communities have 100% coverage by the water network (WaSH MP, 2005). In 2005, a total of 75.5 MCM water was supplied to West Bank governorates (PWA, 2005). Of this, approximately 38.9 MCM was purchased from Mekorot at a cost of 2.42 NIS per cubic meter: a total cost to the Palestinian economy of NIS 94.1 million (USD 21.1 million). Water supplied from Palestinian controlled sources totalled 36.6 MCM, with 3.9 MCM of this amount being water from agricultural wells upon which municipalities and rural communities are becoming increasingly dependent.

It is estimated that approximately 12% of all water supplied to municipalities is used for public, industrial, and commercial uses, based on data collected for the Palestinain Water Strategic Planning Study (PECDAR, 2000). Thus annual per capita domestic water supply can be calculated, based on PCBS population projections for 2005, to be 28 m^3 per year. This amounts to an average of 76.7 L/p-d, which is well below the WHO recommendation of 150 L/p-d. This figure does not even take into account water losses through leaking pipes, a problem that is endemic in the poorly designed and maintained internal water infrastructures of Palestinian municipalities. This problem is a legacy of minimal investment in these infrastructures throughout the period of Israeli occupation from 1967 to 1993 (World Bank, 1993). The average age of water networks in Palestinian communities is around 19 years (WaSH MP, 2005). Thus water loss is high, averaging 17% in WBWD distribution systems, 28% in PWA systems, and ranging from around 31% to as high as 52% in municipalities (PWA, 2003). Taking water losses into account, the PWA estimated in 2003 that the actual average consumption rate per person did not exceed 50 L d^{-1}.

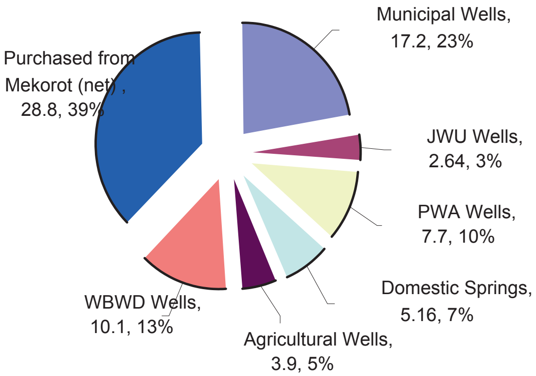

Figure 2. Water supplied to West Bank governorates from different sources in 2005. Numbers represent MCM water per year and % of total supply. (Compiled from PWA (2005) Quantities of Water Supply in West Bank Governorates, 2005).

Approximately 257 West Bank communities, constituting 13% of the population are not connected to the water network (PWA, 2003). These communities are completely dependent upon water tankers, which fill from various networked sources; and on rainwater collection methods, untreated spring water, and agricultural wells. All of these sources carry higher health risks than drinking piped water that has received some form of treatment. It is estimated that there are currently approximately 80,000 houses in the West Bank utilizing rooftop rainwater harvesting cisterns. Each cistern has the capacity to harvest approximately 80 m^3 of water per year. Thus the additional water, mostly for domestic use, made available by this method is about 6.4 MCM per year. Given that there are around 240,000 houses in the West Bank at present, there is great potential to increase water supply by building additional cisterns and also making the construction of cisterns a precondition for building permits for new buildings.

The cost of tanker water has increased in recent years, in proportion with the difficulty and danger of delivering it; given military closures, curfews, and road blocks. In general, tanker water now costs between 10 and 20 NIS per cubic metre, a price increase of 50–100% compared to pre-Intifada prices (WaSH MP 2005). This is an expense that most households can ill afford, particularly in the light of the economic effect of the Intifada and current international sanctions, causing widespread unemployment and poverty.

2.3. SUPPLY DEFICIT

Based on WHO recommendations that each person should receive 150 L of fresh water per day, the total deficit in domestic water supply for 2005 was 41.61 MCM for the whole of the West Bank (note that no deductions were made for water use by the industrial sector or for water losses, thus figures represent gross supply rather than actual consumption). Thus, on average, domestic water supply covered only 64% of demand. However, some areas face more severe problems than others. The governorates facing the most severe deficits in proportion to supply are Tubas, Jenin, Nablus, and Hebron (See Figure 3), where gross per capita supply amounts to only 46, 52, 79, and 91 L/p-d, respectively.

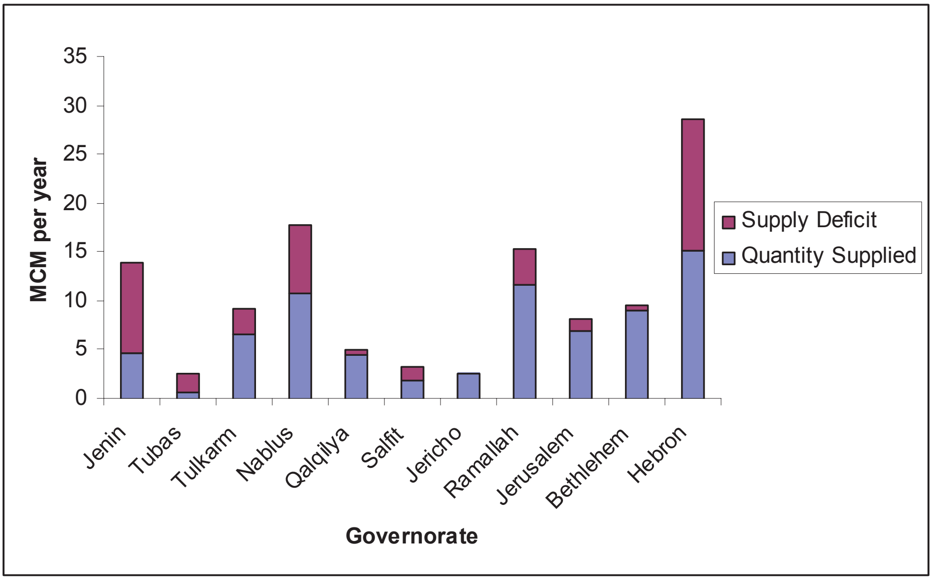

Figure 3. Domestic water supply and demand in West Bank governorates in 2005. (Compiled from PWA (2005) Quantities of Water Supply in West Bank Governorates, 2005. Demand is based on WHO recommendation of 150 L/capita/day).

Taking into account industrial water consumption (around 12%) and water losses (which can be as high as 50%), it is clear that the populations of these governorates are facing severe water shortages and that urgent action is required to ameliorate the situation and supply additional water to these areas, both through developing additional water supplies and through rehabilitating infrastructure to reduce losses.

According to the National Water Plan (PWA, 2000), water demand in the agricultural sector in the West Bank was expected to rise from 85 MCM per year in 2000 to 166 MCM per year by 2005. The current supply is about 70.1 MCM per year. Hence water availability for the agricultural sector has in fact decreased since 2000 due to destruction, confiscation, and isolation of wells in the north of the West Bank to make way for the building of the Separation Barrier (WaSH MP, 2004).

2.4. WATER QUALITY

Water quality in the West Bank is generally considered acceptable. There are no serious indications of pollution in the deep aquifers. However, there is some contamination of water in the shallow aquifer (Jericho area) which is more vulnerable to pollution due to the unconsolidated nature of its geomorphology and the permeability of the gravels and marls that comprise it. The chemical composition of the rocks in the Jericho area also leads to a high mineral content in the water, which is extremely obvious from the high proportion of wells and springs in that area which produce water with a high Ca, K, and Mg content. It is also evident that the shallow aquifer is more saline than any of the other aquifers, due to the high Cl and Na content of the water in the Jericho area. This is partially due to the chemical reactions taking place between the rocks and the water, and possibly also due to overexploitation of various well fields, which has caused drops in yields from various wells as well as salinization of the resource.

Qalqiliya, Tulkarem, and Jericho, which are the governorates with the largest irrigated farming industries have shown nitrate levels in excess of the WHO recommended 50 mg/L (ARIJ, 2006). Nitrate levels in groundwater have been increasing over recent decades in most governorates as a result of drainage of excess fertilizers. Nitrate pollution is observed in Hebron, Bethlehem, Jericho, Nablus, Tubas, and Qalqilya. Springs are more susceptible to contamination than wells as often agricultural runoff and untreated wastewater drain into them.

Biological contamination may be a major problem in the West Bank. A recent report by the USAID funded Environmental Health Project (EHP, 2003) found that over half the households in the West Bank may be drinking fecally contaminated water. Apparently this problem is more severe in the case of tanker water (only 35% of tested samples were not contaminated), than for piped water (59% uncontaminated). However, the prevalence of fecal bacteria in piped water is extremely worrying, and is an indicator of the lack of adequate wastewater treatment in the West Bank, which has only three functioning treatment plants (Tulkarem, Ramallah, and El Bireh), only one of which, El Bireh, is properly functional. Gastrointestinal infections were found to be increasing in prevalence, particularly among children. Thus it is vitally important that the wastewater situation is addressed, and that money is invested in building additional treatment facilities. This would have dual advantages in that the treated wastewater could be used for irrigation. However, the priority of the PWA is to supply adequate quantities of drinking water to the Palestinian population, a goal that is still far from realization.

3. The Water Situation in the Gaza Strip

3.1. WATER RESOURCES

After Kuwait, the Gaza Strip is the next most "water poor" region in the world, with a total of 52 m^3 of water available per person per year for all uses. It is also an area of high population density, with around 1.2 million people crowded into less than 400 km^2, and a high population growth rate. The Gaza Aquifer is the only significant source of water in the Gaza Strip, as much of the water of the Wadi Gaza is diverted in Israel. The natural recharge of the aquifer plus return flows is estimated to total approximately 121 MCM per year (CAMP, 2000).

TABLE 3. Water balance of the Gaza Aquifer. (Compiled from CAMP, 2000; PCBS, 2004)

Inflows (MCM per year)			Outflows (MCM per year)	
Precipitation		35	Domestic wells	74.9
Lateral inflow		36.6	Agricultural wells	82
Return flows	Pipe leaks	12.5	Natural groundwater Discharge	8.5
	Wastewater	10.5		
	Irrigation	22.5		
	Other*	3.5		
Total		120.6	Total	165.4
Net Balance (deficit)		–44.8		

* This number includes recharge from wastewater treatment plants and Wadi Gaza

3.2. WATER SUPPLY

It is estimated that there are currently over 4,000 agricultural wells in Gaza, withdrawing around 82 MCM water per year from the aquifer (PCBS, 2005). In addition, there are around 125 domestic wells, which withdraw an annual total of approximately 74.9 MCM (PCBS, 2005). Domestic wells are all managed by the newly formed Coastal Municipalities Water Utility (CMWU), although this institution is still in a transitional phase, as it only became operational in 2005. According to reports by the PWA, approximately 95% of Gaza residents receive service.

Under the terms of Oslo II, 5 MCM per year should be supplied by Mekorot; however in recent years this amount has fallen considerably to around 2.8 MCM per year (WaSH MP, 2005). Thus Gaza's total domestic water supply totals approximately 77.7 MCM per year. If 12% of water is used for industrial/ commercial purposes, this gives a daily per capita consumption of 135 L/p-d for domestic purposes. However, the water infrastructure in the Gaza Strip is in an even worse state than that in the West Bank, and losses through pipe leakage are assumed to be considerable. Losses were higher than 50% in 1995 when control over resources and infrastructure was handed over to the Palestinians (PWA, 2003b), and given the repeated missile bombardments of Gaza during the Intifada and more recently "Operation Summer Rain" (June 2006), this situation has not improved, despite high investment from donors. Even so, it is clear that the water deficit in Gaza is not nearly as severe as in the West Bank. However, there is a major problem with water quality, due to over abstraction of the aquifer causing intrusion of saline water both from the Mediterranean and from Israel, and most piped water does not meet WHO drinking water standards.

Thus the main challenge facing water planners in Gaza is to reduce pressure on the aquifer by identifying and utilizing alternative sources of water. This fact has been widely recognized for some years, with the Integrated Coastal Aquifer Management Plan (CAMP) being drawn up in 2000 (a USAID-funded project, in collaboration with the PWA). The main components of the CAMP included reducing the amount of water pumped from the aquifer for agricultural irrigation whilst simultaneously improving supply of drinking water to the population by providing additional water from sources other than the Aquifer. These included import of water from Israel, construction of seawater desalination plants and improving wastewater treatment to allow it to be used for irrigation and managed aquifer recharge. It was envisaged that, in the longer term, following a political settlement with Israel and resolution of the Palestinians' water rights in the West Bank, a pipeline could be constructed between the West Bank and Gaza to ensure adequate supplies for the growing population.

If implemented on schedule, it was expected that the CAMP would bring the Gaza Aquifer back into a positive water balance by 2007, whereas "failure to implement the CAMP in accordance with the schedule will result in continuing decline in the quantity and quality of the aquifer water" (CAMP, 2000). However, due to the ongoing violence in the region, implementation of this plan has been extremely slow, and most of it remains undone.

The problem of over abstraction of the aquifer is compounded by a large number of unregistered wells which illegally withdraw water from the aquifer. Of the estimated 4,000 agricultural wells in Gaza, approximately 3,000 are registered, privately owned wells, while there are thought to be around 1,000 unregistered (illegal) wells, and this number is increasing all the time as new wells are dug. The task of bringing abstraction of water by the agricultural sector under control is a daunting one indeed, as there is no single institution with the capacity to enforce regulations, and the difficult security conditions which are often prevalent exacerbate this problem. It is hoped that as the newly formed CMWU gains strength and experience, progress will be made on this front.

In addition to natural water resources, there is one seawater desalination plant at Deir al Balah, which has a daily capacity of 600 m^3, amounting to a potential annual output of around 0.22 MCM. The water produced from this plant is of good drinking quality and is used as a supplementary drinking water supply, being distributed by tanker and purchased as needed. However, given the level of poverty in the Gaza Strip, this option is not open to all. There are two small brackish water desalination plants, but these are of an old and inefficient design and do not produce much water, although technology has improved greatly over the last few years and compact brackish water desalination units are now available at a cost of approximately $200,000; an option that may be significant in alleviating Gaza's water problems in the future.

3.3. WATER QUALITY

The problem of water quality in Gaza is one of the most serious challenges facing the Palestinian water sector. There are serious issues with salinization of the resource due to years of overabstraction. Due to the water deficit, which now amounts to approximately 44.7 MCM per year (see Table 3), the regional water levels have lowered and deep hydrological depressions have formed in the urban areas of the Gaza Strip including Gaza City in the north and Khan Younis and Rafah in the south (see Figure 4).

Inflow of saline water is both a result of seawater intrusion and of lateral inflow from Israel. Moe et al. (2001) have documented salinization rates approaching around 10 mg Cl/L per year. Three major zones of salinization can be identified: the western edge of the aquifer, due to seawater intrusion; a generalized moderate salinization throughout most of the aquifer; and a high salinity zone along the border with Israel. This is because salinization in the aquifer is due to both saline water intrusion and lateral inflow of saline groundwater from Israel. Geochemical and isotopic data indicate that seawater intrusion is limited (Weinthal et al., 2005); and therefore the main source of salinity in the aquifer is actually from inflow of saline water from Israel. This has important implications for management solutions, as it is possible that the problem could be partially remediated (or at least slowed) by pumping additional saline groundwater in Israel, slowing the inflow (Weinthal et al., 2005). Currently only 18% of drinking water wells are under the WHO limit of 250 mg Cl/L (UNEP 2003). If no action is taken, it is expected that the entire aquifer will degrade beyond usability within 15 years (Jansen 2006; CAMP, 2000). Additional water problems associated with salinity are high boron and fluoride content. Boron concentrations in the eastern part of the aquifer exceed 1 mg/L (Vengosh et al., 2002),

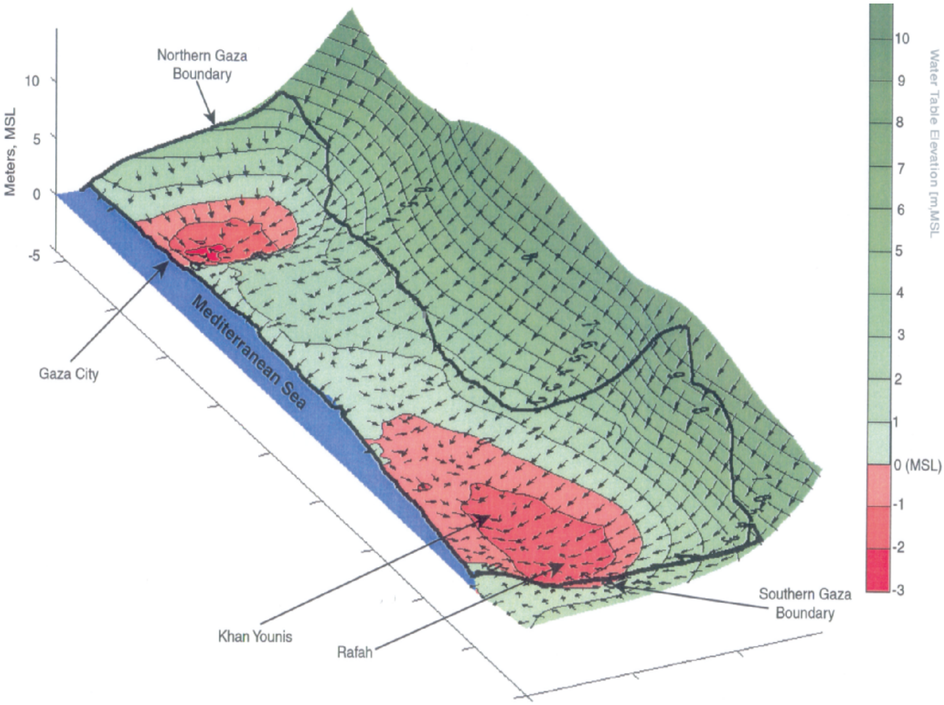

Figure 4. Regional water levels in the Gaza Aquifer, schematic representation. (From the Project Management Unit of the PWA.)

a level of contamination that not only has potential toxic effects on human health but is also detrimental to sensitive agricultural crops such as citrus fruits that are grown in that area. This will reduce the yield and put further strain on the already struggling farming economy of Gaza.

The other serious pollutant of the aquifer is nitrate, which in some areas reaches concentrations of over 500 mg/L far above the WHO guideline of 50 mg/L total N. Over 50% of drinking water wells are contaminated above WHO recommendations (UNEP, 2003); but nonetheless continue to distribute poor quality water to communities due to a lack of alternative resources. Nitrate pollution comes primarily from wastewater contamination and secondarily from pollution with agrochemicals. Nearly 80% of wastewater in Gaza receives no form of treatment. Unfortunately the areas of the aquifer most vulnerable to pollution are in the heavily populated north and south of the Gaza Strip, where water infiltrates easily into the sandy nonsaturated layers that overlie the aquifer. Chloride pollution is not severe in these areas, as rainwater infiltrates readily and dilutes saline groundwater. However, for the same reason, heavily polluted wastewater, produced in large amounts in Gaza City, Khan Younis and

Rafah, also infiltrates the aquifer and heavily pollutes the wells that are least contaminated with chloride. Thus there is a reverse relationship between nitrate and chloride contamination. As a result of this, less than 10% of the wells in Gaza meet WHO drinking water standards (Weinthal et al., 2005).

Thus it is clear that the water crisis in Gaza is underlain by accelerating deterioration of the water quality in the Gaza Aquifer caused by years of overabstraction and severely inadequate wastewater treatment facilities. If no action is taken, there will be an environmental and humanitarian disaster as there will be no fresh water resources in Gaza to supply drinkable water to over 1 million residents. It is imperative that pressure on the aquifer is lifted, through utilizing alternative sources of water, particularly in agriculture. Improving wastewater treatment would have dual benefits in both reducing contamination and providing alternative water for irrigation purposes. However, as mentioned earlier, controlling abstraction from agricultural wells is no easy task in the difficult security conditions that are currently prevalent. Implementing large infrastructure projects is also problematic, particularly in areas considered "security zones" by Israel. In fact, cooperation from Israel is imperative in Gaza, not only to boost donor confidence and allow projects to progress, but also potentially to stem lateral inflow of saline water from Israel to Gaza.

Weinthal et al. (2005) proposed a solution whereby Israel would pump more water upstream of Gaza (to the east), thus improving the quality of the aquifer, if coupled with a reduction of pumping in Gaza. Furthermore, this water could be desalinized on the border, utilizing modern advanced reverse osmosis desalination procedures, and distributed as drinking water within the Gaza Strip. This would provide an alternative water resource and hence reduce pressure on the aquifer, whilst simultaneously reducing inflow of saline water. Such a solution would also have benefits in promoting Israeli cooperation and lessening security concerns for donors. However, there would need to be a great deal of prior negotiation and guarantees of goodwill on both sides; and furthermore, the emergency wastewater situation requires immediate and urgent attention.

In fact, a combination of several different approaches is likely to prove the most efficient in improving the situation in Gaza – through import of additional water, wastewater treatment and reuse, desalination of seawater and brackish groundwater and reduction in abstraction for the aquifer. The political situation at present places heavy constraints on cooperation with Israel; and on implementation of projects. However, both are urgently necessary in order to prevent an environmental and humanitarian catastrophe; and hence international support and intervention are imperative.

4. Conclusions

It is clear that the PT are facing several severe challenges with regards to water management; both from a humanitarian and an environmental perspective.

In the West Bank, many communities face severe water shortages, and inadequate water and wastewater treatment facilities are causing a health hazard due to bacteriological contamination of water. Whilst there is much to be done in terms of rehabilitating existing infrastructure, building and upgrading wastewater treatment facilities and building new water distribution pipelines and reservoirs, expansion of water supply is seriously hampered by existing agreements with Israel. The amount of water allotted to the Palestinians under the Oslo II Agreement is inadequate to meet the basic needs of the population.

Whilst some additional water may be developed from the Eastern Aquifer, and some harvested by rainwater and surface runoff capture, these amounts will not fill the supply gap. The PA is currently practically bankrupt, and incapable of paying for imported water from third parties. Due to the inequitable allocation of water resources between the PT and Israel, purchasing more water from Israel is not perceived to be a viable long-term option, and is politically contentious. The perception is that Palestinians are buying from Israel what rightfully belongs to them in the first place. Furthermore, as both populations grow and water becomes ever more precious, there is no guarantee that Israel would continue to sell water to the Palestinians, and hence a commercial agreement would carry with it no long-term guarantee of water security for Palestine. Granting of equitable Palestinian water rights to the natural resources of the region is widely perceived to be the only means of securing long-term water security, and of meeting the basic needs of the population.

Such an agreement would also have the potential to slow the degradation of the Gaza Aquifer, as additional water could be supplied from the West Bank by building a pipeline to Gaza. This could not be done without the agreement and cooperation of Israel as the pipeline would cross Israel, nor could the pipeline be maintained without continuing Israeli cooperation. Alternatively, water could be supplied to Gaza by Israel in lieu of water utilized by Israel from "Palestinian" resources (i.e. from wells within the West Bank or various Mountain Aquifer sources, or Palestinian water rights to the Jordan River). The PWA has estimated that Palestinian water demand will rise to 907 MCM per year by 2020, taking into account population growth and economic development (PWA 2003b).

TABLE 4. Sources of additional water for Palestinian use to fulfil projected needs for 2020. Numbers represent MCM water per year. (From PWA, 2003b)

Water source	Amount
Mountain Aquifer	504
Coastal Aquifer	82
Jordan River	100
Surface runoff	20
Treated wastewater effluents	90
Desalination of brackish low quality water	55
Desalination of seawater/import of water	56*
Total	907

*Shortfall in water due to failure to secure rights to ground and surface water must be made up from these sources.

Currently, Palestinians utilize a total of around 310 MCM per year. Thus supply needs to be trebled to meet projected demand. The main source of additional water would be the Mountain Aquifer, followed by the Jordan River, with desalination of brackish and sea water and harvest of surface runoff making up the remainder (see Table 4). If these amounts were made available, water use from the Gaza Aquifer could be reduced to an amount within the sustainable potential of the resource.

As mentioned earlier, the natural water resources of the region are fully utilized. Hence increase in water use by Palestinians must be met by equal or greater reduction in use by Israelis if damage to the resources is to be avoided. Thus Israel would have to relinquish a total of 486 MCM per year (about 30% of the country's fresh water supply) to comply with Palestinian demands. As Israeli water demand is also expected to rise over the coming decades, it is clear that in order to do this, Israel would have to invest considerable funds in alternative water supplies; either importing water or developing desalination techniques and expanding wastewater reuse; or severely reduce water use in the agricultural and industrial sectors, to the detriment of the country's economy.

Thus it is clear that there are no easy solutions to the water problems of the PT. What is clear is that no solution or real progress can be made without negotiation and cooperation with Israel. Furthermore, the sum of the projected water demand of both countries adds up to much more than the sustainable potential of the available resources. Thus there needs to either be considerable technological development of nonconventional resources, large-scale water import, or considerable scaling down of demand through practice of water conservation. Any cutbacks in water use are likely to be in the agricultural and industrial sectors rather than the domestic sector. The agricultural sectors in both countries account for approximately 50% of water use. However, the

Israeli agricultural sector is considerably more developed than its Palestinian counterpart, and water use is considerably greater: 1,129 MCM per year compared to 155 MCM per year. Thus the potential to make cutbacks is considerably greater. Nevertheless, Palestinians may have to curb aspirations to develop irrigated agriculture to the extent that they would like to; and certainly make every effort to develop in a way that is compatible with the sustainability of the water resources, a commitment that is already articulated in the water policy of the country (Water Law No. 3, 2002).

In the past, water negotiations have been grouped together with negotiations over other contentious issues such as settlements, refugees, and Jerusalem. Given the urgency of the Palestinian water crisis, and the gravity of the environmental damage that could ensue if water is not sustainably managed, this should no longer be the case. New water agreements must be negotiated with Israel as a matter of priority, and separate issues should not influence the success or failure of such negotiations. Achieving cooperative and sustainable water management will be no easy task; however there is an absolute necessity to do so if long-term water security is to be achieved for either Israelis or Palestinians.

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SECTION II

POLICY AND MANAGEMENT OPTIONS

ENVIRONMENT AND SECURITY IN THE MIDDLE EAST: CONCEPTUALIZING ENVIRONMENTAL, HUMAN, WATER, FOOD, HEALTH AND GENDER SECURITY

HANS GÜNTER BRAUCH[1]

Free University of Berlin, Otto-Suhr-Institute of Political Science
United Nations University, Environment and Human Security (UNU-EHS)
Peace Research and European Security Studies (AFES-PRESS)

Alte Bergsteige 47, 74821 Mosbach, Germany

Abstract: This chapter reviews three features of the reconceptualization of security: a *widening*, *deepening* and, *sectorialization* from "hard" or "national security" concepts to wider "soft" security concepts, such as environmental, human, water, food and, health security. This rethinking of security in many parts of the world has been triggered both by the end of the Cold War and the implosion of the former Soviet Union (1989–1991), as well as by the attacks of 11 September 2001 and their impacts on security thinking. These new concepts will be introduced first reflecting the global academic and political debates and in a second step the regional debates in the Middle East or their applications to issues in the Middle East will be discussed. The chapter is structured in six sections. After a brief introduction to the theme "environment and security in the narrow Middle East" (Israel, Egypt, Palestine, Jordan, Lebanon, Syria), section 2 refers to the reconceptualization of security concepts on global environmental change. Section 3 explores the environmental dimension of security, the use of environmental security concepts in and on the Middle East, as well as selected environmental security issues within the region. Section 4 discusses the emergence of the debate on human security, on the use as well as the criticisms of its

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C. Lipchin et al. (eds.), Integrated Water Resources Management and Security in the Middle East, 121–161.

use in the Middle East, and its application to policy issues in the region. Section 5 contrasts the global academic and policy-oriented conceptualizations of water, food, and health security with conceptual debates and applications in examples on the region. Section 6 deals with gender security and finally section 7 touches on the inherent tensions between "hard" (top-down) and "soft" security concepts in the Middle East.

Keywords: environment; security concepts; national, environmental; human; water; food and health security; short- and longer term impacts of war on the environment: oil spill in Lebanon, forest fires in Israel

1. Introduction: Environment and Security in the Middle East

Geographically this chapter focuses on a narrow Middle East, i.e. on Israel and its direct Arab neighbors, on Egypt, Jordan, Lebanon, Syria, as well as on Palestine (Gaza and West Bank). This semiarid and arid region shares the Mediterranean flora and fauna, as well as the specific Mediterranean climate with long and hot summers with hardly any rain where most of the precipitation falls in autumn and winter. It is part of the desert region extending from the Sahara in North Africa, via the Sinai, Negev, the Jordanian, and Syrian deserts to the deserts in Central Asia, and thus water scarcity and stress are common challenges for the whole area (see chapter by Brooks in this volume). The region has been a cradle of civilization and of three monotheistic religions.

While the common Mediterranean environment and climate ignores national borders (Brauch, 2001a, 2003a), the Holy Land has been highly disputed and one of the most conflict-prone regions since end of World War II (Pfetsch, 2003). Water as a scarce renewable natural resource has been highly contested in the shared aquifers, in the Golan and Jordan River and has been a key national security concern for all governments in the region (Dombrowsky, 2003; see chapters by Netanyahu et al. in this volume). However, irrespective of, and despite, the conflict, water cooperation between Israeli Water Commission and the Palestinian Water Authority and their officials has continued (Husseini, 2006, 2007; Shuval and Dweik, 2006, 2007). Thus, water has been regarded first and foremost as a "hard security issue" primarily from a national, political, and economic perspective while less emphasis has been put on environmental, human, water, food, and health security.

Emerging from the global debate on the *reconceptualization* of security since the end of the Cold War (1989–1991) this chapter will discuss in section 2 why the "modern" concept of territorial sovereignty and a focus on a narrow – primarily militarily focused – national security concept has prevailed both in

Israel and in Egypt while the government and scholars and institutions in Jordan – with Canadian support – have introduced the human security concept into the discourse within the Arab World (Chourou, 2005).

As part of the debate on a “rethinking of security”, three discussions on “soft security” concepts are reviewed resulting from a *widening* (environmental dimension, section 3), a *deepening* (from national to human security, section 4) and a *sectorialization* (water, food and health security, section 5) of security. However, due to the prevailing conflict and the dominant Hobbesian approach among most parties and many scholars in the Middle East, wider thinking on environmental, human, water, food, and health security has been marginal (Brauch, 2003b, c, 2006b).

The specific environmental threats and challenges that have faced the Mediterranean and the Middle East during the last 6 decades (1945–2005) and will confront the region have been analyzed elsewhere in detail (Brauch, 2001a, 2003b, c, 2004, 2006a, b).

The concluding part discusses ongoing (FoEME, UNEP, 2003, 2006) scientific and political efforts, and potential future initiatives addressing environmental security challenges in the Middle East and offers ideas for specific future policy proposals.

2. Reconceptualizing Security in Light of Global Environmental Change

As a social science concept, “*security* is ambiguous and elastic in its meaning” (Art, 1993: 820). Wolfers (1962) pointed to two sides of the security concept: “Security, in an *objective sense*, measures the absence of threats to acquired values, in a *subjective sense*, the absence of fear that such values will be attacked.”[2] For social constructivists security is “what actors make of it” (Wendt, 1992), thus adding an *intersubjective* meaning. Among the latter, the *securitization approach* of the *Copenhagen School* (Buzan et al., 1998) has been most prominent. According to Wæver (2007, in press):

> Securitization is the discursive and political process through which an intersubjective understanding is constructed within a political community to treat something as an existential threat to a valued referent object, and to enable a call for urgent and exceptional measures to deal with the threat.

The *perception* of security threats, challenges, vulnerabilities, and risks (Brauch, 2003a, 2005a) depends on the worldviews or traditions of the analyst

[2]The term “security danger” is used to refer to objective security threats, challenges, vulnerability and risks while “security concern” refers to the perceptions of these dangers.

and on the mind-set of policy-makers. Three basic views have been distinguished by the English school (Bull, 1977; Wight, 1991) that of: (a) *Hobbesian* pessimism (realism) where *power* is the key category; (b) *Kantian* optimism (idealism) where *international law* and *human rights* are crucial; and (c) *Grotian* pragmatism where *cooperation* is vital (Brauch, 2003a, 2003e). This typology refers to three ideal-type approaches (Max Weber, 1903–1917, 1949) to security that may be associated with other philosophical traditions elsewhere (Brauch et al., 2007a). Snyder (2004) distinguished among three rival theories of realism, liberalism, and idealism (constructivism). Booth (1979, 1987: 39–66) argued that "old mind-sets" often have distorted the assessment of "new challenges", and that many old mind-sets have survived the global contextual change of 1989–1990 unchanged (Booth, 1998: 28).

Influenced by these worldviews and mind-sets, security is a key concept of competing schools of (a) *war*, *military*, *strategic*, or *security studies* from a Hobbesian or realist perspective, and (b) *peace and conflict research* that has focused on conflict prevention from a Grotian pragmatist and/or Kantian idealist view. Since 1990, the distance between both schools has narrowed, but since 2002 it has again widened. New approaches and interparadigm debates relevant for security have emerged among traditional approaches, critical security studies, and constructivist approaches.

Many authors have observed a *widening* of the security concept in OECD countries to five dimensions (Buzan et al.,1998), a *deepening* (from the state to other referents and levels of analyses) and a *sectorialization* (energy, food, health, water, etc.), while in other countries a narrow military security concept has prevailed (Brauch et al., 2003a). "Gender security" may be added as a separate category especially from a human security perspective (see Oswald in this volume).

All three security concepts coexist in the UN system, namely a Hobbesian state-centered political and military "national security" concept, an extended *Grotian* "cooperative security" concept that includes economic, societal, and environmental dimensions, and a *human security* concept that has been promoted by the Human Security Network (HSN), the Commission on Human Security (CHS, 2003) and by the Secretary General's report *In Larger Freedom* (Annan, 2005). Sectoral concepts of "water security" (UNEP, UNU), "food security" (FAO) and "health security" (WHO) have been used by many UN agencies, nongovernmental organizations (NGOs) and in the academic community, however, often with different connotations in Organization for Economic Cooperation and Development (OECD) and developing countries. These concepts have been used extensively in reports by those UN agencies that have been active in the Middle East.

3. Widening: The Environmental Dimension of Security

Since 1990, a fundamental reconceptualization of security emerged (Buzan et al., 1998; Abdus Sabur, 2003; Brauch, 2005a; Brauch et al., 2007a). In European security discourses, an expanded security concept has been used by governments and in scientific debates (Buzan et al., 1998; Wæver et al., 2007). Many authors have observed a *widening* of the security concept to five dimensions (military, political, economic, societal, and environmental), a *deepening* (from the "state" to other "referents" or levels of analyses) and a *sectorialization* (energy, food, health, water, etc.), while in other countries a narrow military security concept has prevailed (Kam, 2003; Selim, 2003, see Table 1).

TABLE 1. Widening and deepening of security concepts (Brauch, 2003a, 2005a)

Security dimension ⇒ Level of interaction (reference point) ⇓	Military	Political	Economic	Social	Environmental ↓ (longer-term environ-. mental challenges)
Human ➔					Cause and victim
Societal/Community					↓↑
National (short-term threats)	Middle East discourses on "security dilemma"				↓↑ "survival dilemma"
International/Regional					↓↑
Global/Planetary ➔					GEC

3.1. RESEARCH PHASES ON ENVIRONMENTAL SECURITY

During the *first* research phase on environmental security, Westing (1976, 1984, 1986, 1988, 1989a, b, 1997a, 2003) analyzed the manifold impacts of wars (World War II, Korean, Vietnam, and Gulf wars) on the environment, while Ullman (1983), Mathews (1989), and Myers (1989, 1994) put environmental concerns as "new threats" on the US "national security" agenda. This policy-oriented environmental security debate – primarily in the USA – in the 1980s and 1990s was followed by a *second* empirically oriented, theory–based, and case-study focused research phase to which two research teams, the "Toronto group" led by Homer-Dixon (1991, 1994, 1999, 2000) and the "Swiss group" led by Bächler and Spillmann (1996a, 1996b, c, 2002), made significant contributions by addressing linkages between environmental scarcity, degradation, and stress on the one side, and violent outcomes on the other. Since the late 1990s a *third* research phase (focusing, e.g. on syndromes of global change and on their mitigation, as well as on water conflicts and cooperation) has moved into many different theoretical directions and empirical foci achieving little integration.

Dalby, Brauch, and Oswald (2007) have reviewed the lessons learned in these three phases while Oswald, Brauch, and Dalby (2007) proposed a *fourth* research phase linking the environmental security dimension with a human security focus. This phase should also address a shift to the *Athropocene* (Crutzen and Stoermer, 2000; Crutzen, 2002), a focus on a *Human*, *Gender*, *and Environmental* (HUGE) security *concept* (see Oswald, 2001, 2007 and in this volume) and a research program on *human*, *environmental security*, *and peace* (*HESP*, see Brauch, 2003a, 2005a). In addition, Brauch (2005a, 2007a) suggested a PEISOR (*P*ressure-*E*ffect-*I*mpact-*S*ocietal *O*utcome-*R*esponse) model for the linkages between the causes of global environmental change, environmental scarcity, degradation, and stress, with extreme and sometimes fatal outcomes, such as extreme weather events (hydrometeorological hazards), distress migration, domestic crises, complex emergencies, as well as small-scale violence.

The *Global Environmental Change and Human Security* (GECHS, 1999) shifted the focus to linkages between global environmental change and human security, while Bogardi (2004) and Brauch (2003a, 2005a, b) suggested to focus the human security discourse on its environmental dimension, especially on interactions between the individual or humankind as the cause and victim of factors of global environmental change both in anthropogenic and natural variability contexts (Bogardi and Brauch, 2005a). This can be shown for climate change where the human consumption of fossil fuel has significantly increased global warming since the beginning of the industrial age (IPCC, 2001). Major victims of this consumption pattern are often the poorest and most vulnerable people in developing countries.

3.2. ENVIRONMENTAL SECURITY CONCEPTS IN THE MIDDLE EAST

In the Middle East, the environmental security concept has not been used by officials in Israel and Palestine (Twite, 2003, 2007; Newman, 2007; Dajani, 2007) while there has been some debate by scholars in Arab countries (Selim, 2007). However, during the Clinton Administration the State and the Department of Defense (DOD) together with the Department of Energy (DOE), and the Environmental Protection Agency (EPA) developed a *Middle East Environmental Security Initiative*[3] with participants from Jordan, Israel, and the Palestinian Authority and staff from DOE's National Laboratories and EPA with the objectives to:

- Provide a forum in which "sub-diplomatic" regional technical cooperation may flourish and promote confidence-building.
- Use US DOE and EPA technologies to help the region address environmental concerns that will directly impact national and regional stability.

[3]See at: http://www.jewishvirtuallibrary.org/jsource/Environment/envtsec.html

- Motivate the regional participants to use this effort as the basis for sustained action on these critical environmental issues.
- Wherever possible, encourage the growth and evolution of these projects into opportunities for local economic development.

The project began in 1997 with an effort to define the most critical regional environmental concerns, identifying two key areas: the need for renewable energy sources, and strategic concerns on the quantity, quality, and reuse of water, and the potential to develop a regionally cooperative approach. In July 1998, this culminated in a workshop held in Amman that produced four technical proposals: using renewable energy to power remote, portable water pumping, and desalination stations for Bedouins in the desert areas; treating waste water and reusing it for irrigation; and proposals involving aspects of hydrological modeling. These proposals have been developed jointly by a project team including members from all four participating entities and have been closely coordinated with a broad spectrum of US agencies (State Department, USAID, ACDA, USIA, EPA, DOD, and USGS, including the World Bank. However, while this definition of priorities may have influenced thinking among officials and experts taking part in the meetings, it is not easy to identify specific projects which owe their origin to discussions at the Amman workshop.

Since the early 1990s, there have been numerous efforts in the USA to launch environmental security research and dialogue projects on the Middle East with partners from the region of which only a few will be mentioned without attempting a comprehensive survey. The Woodrow Wilson International Program for Scholars in Washington maintains an *Environmental Change and Security Program* that deals with environment, population, and security, revealing the links that connect natural resources (air, water, land, forests) to conflict and cooperation. The Wilson Center's *Middle East Program* focused on policy implications of long-term political, social, and economic developments in the region and individual states but not on environmental issues.[4]

In June 2002, a group of scholars and practitioners held an intensive dialogue on environmental issues in Palestine and Israel at Brown University (USA). In July 2003, a project team designed a 3-year program, entitled "The Middle East Environmental Futures (MEEF) Project", on the environment in the region pursuing these goals:

> It engages in interdisciplinary and cooperative environmental research and outreach in Palestine and Israel. It seeks to assess the current and future state of the environment in the region and to explore through an in-depth dialogue the environmental identities and desires of the two nations …. By integrating the natural/physical and the social sciences, it will produce

[4] See at: http://www.wilsoncenter.org/index.cfm?fuseaction=topics.welcome

> policy-relevant publications that will integrate expert knowledge with community-level concerns. The knowledge … will provide a basis for dialogue among community groups, non-governmental organizations, media and policy makers in order to inform and stimulate public discourse and policymaking for a healthier future environment in Palestine and Israel.[5]

Among the MEEF projects that have been funded so far are:

- A MEEF field trip to examine industrial pollution in upper Hebron/Khalil river (2005)
- MEEF Sponsors Student Research Projects in Israel, Jordan, and Egypt (May 2005)
- Conference Proceedings – Palestinian and Israeli Environmental Narratives (2005)
- MEEF Researchers Investigate the Future of the Dead Sea Basin (March 2005)
- Presentation at the Borders in Transition VII (BRIT VII) conference in Jerusalem (2005)
- Environmental Narratives Conference (December 2004)
- Wadi Khalil/Nahal Besor Environmental Assessment Proposal (May 2004)
- Border zones research proposal (September 2003)

These two examples indicate that an interest in environmental security issues in the Middle East seems to exist primarily outside the region, especially in the USA. David Newman (2007) has pointed to an "environmental schizophrenia" in the security discourse in Israel and Palestine.

3.3. ENVIRONMENTAL SECURITY ISSUES IN THE MIDDLE EAST

Environmental issues have been pursued by all governments in the Middle East without linking them directly to "'security". The activities of two nongovernmental groups that have used the environment security concept and that involve Israelis, Palestinians, and Jordanians will be briefly presented: (a) the *Israeli-Palestinian Center for Research and Information* (IPCRI) and (b) the *Friends of the Earth in the Middle East* (FoEME).

Since 1994, IPCRI has conducted an *Environment and Water Program* "to promote effective cooperation between Israelis and Palestinians in the field of environment with a special emphasis on water issues". IPCRI has "successfully

[5] See the MEEF website with information on the vision, the participants and ongoing projects, at: http://www.watsoninstitute.org/meef/english/vision.cfm

secured cooperation from the Israeli and Palestinian Environment Ministries, local authorities, NGO's, and a wide variety of academic institutions."[6] Among its past activities since 1999 are:

- A course on Environment Conflict Resolution in June 1999 directed by Professor Larry Susskind (Boston, USA) that led directly to the establishment of the Joint Environmental Mediation Service (JEMS).[7]
- A 2-week cooperative training program in July 1999 with the Nature and National Parks Protection Authority of Israel and the Palestinian Ministry of Agriculture designed to improve the ability of Palestinian staff to manage national parks and open spaces.
- A program (May–July 1999) involving the Collection of the Seeds of Wild Cereal Plants from areas threatened by development on behalf of the Israeli gene bank at the Volcani Institute and the University of Hebron to promote long-term relationships between the members of the teams and the institutions involved.
- A residential seminar on the Disposal of Solid Waste in Israel and Palestine in November 1999 with senior officials of the Israeli and Palestinian Ministries of the environment and health, by the city engineers of Hebron, Bethlehem, Salfit, and other local authority officials, and by representatives of the World Bank to secure agreement on future collaboration, and resulted in significant, practical recommendations.

Recent IPCRI projects since 2004 that reflect environmental and water security concerns include:

- Conference on Water For Life (10–14 October 2004, Antalya, Turkey) together with the International Water Resources Association (IWRA) cosponsored by United States Agency for International Development (USAID), the British government, and United Nations Educational, Scientific and Cultural Organization UNESCO[8]
- IPCRI seminar on Israel and Palestine water issues (jointly with SIWI) at the 2004 and 2005 World Water Weeks
- The 2005 World Water Week in Stockholm (21–27 August 2005)[9]

[6]See for details at: http://www.ipcri.org/files/environment.html

[7]See at: http://www.ipcri.org/jems/index1.html

[8]See for the conference announcement at: http://www.ipcri.org/files/water-conference.html and for the presentations at: <http://www.ipcri.org/ files/pp.htm

[9]See at: http://www.worldwaterweek.org/

- NATO Advanced Study Institute (6–17 February 2006, Kibbutz Ketura, Israel)
- Participation in the OPTIMA (OPTImisation for Sustainable Water MAnagement) Project with 14 partners from 12 Mediterranean countries supported by the European Union[10]
- Participation in the GLOWA Jordan River project funded by the German government.[11]

IPCRI has proposed several additional projects including Middle Eastern Water Education/Peace Project, a joint water management for the Wadi Gaza/ Nahal Bezor Basin, a MERC Waste Water Project, and a Forum for the Creative Discussion of Water Issues.[12] IPCRI has documented these cooperative efforts in several books and reports.[13]

FoEME addressed the "Middle East Environmental Security" in a study on the Jordan River pointing to these lessons learned:

1. Third-party mediation (Johnson Plan) even if not formally accepted can be the basis for an informal framework on water sharing.
2. Practical water allocation arrangements … are important for confidence-building measures prior to permanent arrangements.
3. Creation of parallel tracks … provides more flexibility and room for maneuvering in complex water negotiations.
4. Political will for peacemaking and compromise in broader terms (Oslo process) is a key factor before any real progress concerning "water rights" takes place.
5. Once institutional relationships are created on key issues of mutual interest such as water (Joint Water Committee) they appear to withstand despite the collapse of the broader political framework (Bromberg et al., 2001: 6).

They mentioned several short-term initiatives to support more sustainable agricultural practices and alternative income of farmers, to review existing water sector practices and longer term initiatives for creating public awareness by supporting civil society efforts, public education, and region-wide awareness

[10]See at: http://www.ess.co.at/OPTIMA/description.html

[11]See at: http://www.glowa-jordan-river.de/Design/Glowa_JR.htm

[12]See at: http://www.ipcri.org/files/environment.html

[13]See these publications: Twite (2003, 2007); Shuval/Dweik (2006, 2007); *Proceedings of the IPCRI Conference on Micronutrient Deficiency Conditions in Israel and in Palestine and their Prevention*, in: *Public Health Review* Vol. 28 (March 2001); *Proceedings of an International Conference on Public Awareness on Environmental Issues in Israel* (2000); *Our Shared Environment* (1994); *A Proposal for the Development of a Regional Water Master Plan* (1993). For more information on these publications see at: http://www.ipcri.org/files/environment.html

activities, as well as educating policy makers and the media to counter the farmers lobby. Thus, achieving "environmental security" for water requires – in the view of FoEME – both bottom-up initiatives of concerned citizens, awareness of the media, and joint decisions by government officials.

On 6 July 2006, FoEME called on both sides to end the Gaza crisis and requested a

> ceasefire followed by negotiations to end the crises immediately. FoEME calls on the Israeli military and Minister of Defense to refrain from further damage to basic infrastructure and allow for the urgent repair of basic infrastructure facilities damaged. FoEME is particularly alarmed by the impact on drinking water supply to large sections of the civilian population and the health implications of damage to sanitation facilities. FoEME's Good Water Neighbor communities are at this time expressing their solidarity with the Gazan village of Abassan and its residents innocently caught up in the midst of the present violence.[14]

In summer 2006, FoEME pointed to the negative environmental impacts of the War of Israel against the Hezbollah in Lebanon by pointing to the serious "environmental destruction … in both Israel and Lebanon", resulting from the oil spill in Lebanon "of an estimated 15,000–30,000 tons of heavy fuel oil" and "some 600,000 trees have to date been burnt down in forest fires caused by Hezbollah Katyusha rockets".[15]

According to reports by *Friends of the Earth in Europe*:[16]

> In mid July [2006], Israeli warplanes bombed the oil-fuelled power plant of Jiyyeh on the coastline 30 kilometers south of Beirut. Storage tanks caught fire and polluted the air for several days. … Most of the Lebanese coastline north of Jiyyeh and some parts of Syria's shore have been affected. … Beneath the surface a suffocating carpet of heavy fuel oil up to 10 cm thick oil is killing marine life and is poisoning the water…. The negative environmental and health impacts of this catastrophe are expected to increase as more oil washes ashore or solidifies and sinks to the… sea. … The Euro-

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[14]See at: < http://www.foeme.org/press.php?ind=29>; see also the appeal of 16 July 2006, at: <http://www.foeme.org/press.php?ind=32>

[15]See for additional information at: http://www.foeme.org/projects.php?ind=107

[16]For photos by Friends of the Earth Europe, see at: http://www. foeeurope.org/activities/ oil_spill_lebanon/oil_spill_photos_page.html; and at: at: http://www.foeeurope.org/ activities/oil_ spill_lebanon/index.htm>; for satellite images of the oil spill along the Lebanese coast see at: http://www.zki.dlr.de/applications/2006/lebanon/lebanon_2006_en.html ; for photos of the forest fires in Israel, see at: http://www.parks.org.il/BuildaGate5/general2/data_card. php?U= no&Site Name=parks&ItemID=585087277&ValuePage=Card8

pean Union sent advisors to Lebanon and is planning to provide help to Lebanon, in coordination with the United Nations Environment Program (UNEP), the International Maritime Organization (IMO) and with regional institutions.[17]

According to the FoE Europe, Hezbollah missiles and Israeli bombing led to hundreds of fires destroying large forest areas in both countries. In Israel, more then half a million trees have been burnt in about 500 fires. Planning for sustainable reforestation should therefore now begin in Israel and Lebanon. On 17 August 2006, FoEME "appealed to the UNEP to send a team from its "Post-Conflict Branch" to Lebanon and Israel to conduct an "independent assessment of the environmental impacts of the recent war between the Lebanese Hezbollah group and Israel."

While there has been hardly any conceptual debate on environmental security, its concept has been used at least by IPCRI and the FoEME to address the severe environmental security issues, especially those caused by war but also by water scarcity, degradation, and stress.

4. Deepening: From National to Human Security

While the academic debate on environmental security influenced the policy agenda of several international organizations, the human security concept of United Nations Development Programme (UNDP, 1994) triggered a global scientific debate. Human security is a widened "people-centered" security concept (UNDP, 1994) combining its diplomatic, economic, societal, and environmental dimensions focusing on human beings and humankind, comprising four pillars: "freedom from fear" (violence); "freedom from want" (sustainable and human development), "freedom to live in dignity" (rule of law, good governance, human rights) and "freedom from hazard impacts" (environment, hazards, disasters). Owen (2004: 383) suggested a "threshold-based conceptualization of human security" that focuses on "the protection of all human lives from critical and pervasive environmental, economic, food, health, personal and political threats."

4.1. POLITICAL AND ACADEMIC HUMAN SECURITY CONCEPTS

Since 1994, human security has been referred to as an encompassing concept that shifted the referent from the "nation state" to a "human-centered" perspective (Annan, 2001) that deals with the protection of the individual or citizen.

[17]See at: http://www.foeeurope.org/activities/oil_spill_lebanon/index.htm

Human security as *freedom from want* (UNDP, 1994; CHS, 2003) was promoted by Japan (Shinoda, 2007), and *freedom from fear* was pushed by Canada (Dedring, 2007), Norway and members of the Human Security Network (HSN) (Fuentes, 2007). Kofi Annan (2005) added a third pillar *freedom to live in dignity* that stressed the rule of law, human rights, and democracy. Bogardi and Brauch (2005a) proposed a fourth pillar "freedom from hazard impacts" (Brauch, 2005a, b) dealing with sustainable development, the environment, and hazards what also implies the "freedom of future generations to inherit a healthy environment" (Annan, 2000). Human security comprises today four pillars:

- *Freedom from want* (economic, societal security dimensions) by reducing social vulnerability through poverty eradication programs (UNDP, 1994; CHS, 2003)
- *Freedom from fear* (political, military, societal security dimension) by reducing the probability that people confront violence and conflict (UNESCO, HSN)
- *Freedom to live in dignity* (political and societal security dimension) by promoting rule of law, human rights and democracy (Annan, 2005)
- *Freedom from hazard impacts* (environmental security dimension) by reducing vulnerability of societies confronted with natural and human-induced hazards

For Kofi Annan (2001) "human security can no longer be understood in purely military terms, rather, it must encompass economic development, social justice, environmental protection, democratization, disarmament, and respect for human rights and the rule of law". In his view, "large-scale displacement of civilian populations … environmental disasters present a direct threat to human security" that "embraces far more than the absence of violent conflict." He pointed to three building-blocks of the human security concept: "freedom from want, freedom from fear, and the freedom of future generations to inherit a healthy environment – these are the interrelated building blocks of human – and therefore national – security". In his report, *In Larger Freedom,* Kofi Annan (2005) used "freedom to live in dignity" for the human rights agenda.

Human security is closely related to vulnerability, "the latent threat that some dimensions of human insecurity could manifest themselves in crises and disasters". In the report of the Secretary-General on the Implementation of the UN Millennium Declaration, vulnerability is interpreted as a social feature, closely related to poverty, diseases, and lack of (economic) options, characterized by weak governance and underdeveloped infrastructure (UNGA, 2004). Environmental and man-made hazards may expose vulnerability. Disasters may be identified with events of exposed and apparent vulnerability.

In the context of vulnerability of affected communities, both the *creeping deterioration* of the determining factors of human existence (climate, environment, socioeconomic conditions) and the *rapid impact* of extreme events of natural and/or man-made origin are of particular importance. The level of risk they pose in different locations, the vulnerability of societies to them, and the response capabilities have generally worsened and thus contribute to a deterioration of human security. Since 1950 there was a marked growth in the frequency and magnitude of natural hazards and in their economic consequences (Munich Re, 2006; IPCC, 2001; UNISDR, 2004; UNDP, 2004). The exposure of the poor to extreme weather events and the subsequent disasters may delay development for decades.

Human security focuses on threats that endanger the lives and livelihoods of individuals and communities. Safeguarding and improving human security requires a new approach that would enable a better understanding of interrelated variables – social, political, institutional, economic, cultural, technological, and environmental. Deterioration of these factors amplifies the impacts of environmental change and their superposition with the consequences of extreme events.

While man-made and natural hazards cannot be prevented, the impact of these tragic events can be reduced by both measures of early warning and better disaster preparedness. "Freedom from hazard impact" would imply that people can mobilize their resources to address sustainable development goals rather than remain in the vicious cycle of the survival dilemma (Brauch, 2004). To achieve "freedom from hazard impact" requires four different types of hazard-specific policies and a combination of technical, organizational, and political measures in case of: (a) *slow-onset hazards*, (b) *rapid-onset hydro-meteorological hazards*, (c) *rapid-onset geophysical hazards*, and (d) *man-made disasters*: technical, industrial, and traffic accidents or a combination of these.

"Human security as freedom from hazard impact" is achieved when people who are vulnerable to these manifold environmental hazards and disasters (floods, landslides, and drought) that are often intensified by other associated societal threats (poverty), challenges (food insecurity), vulnerabilities and risks (improper housing in highly vulnerable flood-prone and coastal areas) are better warned of impending hazards, prepared and protected against these impacts and are empowered to prepare themselves effectively to cope with the "survival dilemma".

4.2. HUMAN SECURITY CONCEPTS IN THE MIDDLE EAST

There has been no intensive academic debate on Human Security neither in the Arab world (Chourou, 2005, 2007) nor in Israel. Bechir Chourou (2005: 19), a professor of political science from Tunisia, based his analysis for UNESCO of the ethical, normative, and educations frameworks for promoting human security in the Arab states on Owen's (2004: 383) definition and on CHS's suggestion on the "vital core of human lives." Chourou distinguished *first* between factors on the global, the regional, and national level that have an impact on efforts to achieve human security, *then* he operationalized the four elements of a human security definition (physical integrity, needs, capabilities, and participation), and *finally* he suggested an educational framework to allow the Arab world to reduce insecurity and to achieve human security.

He pointed to two local barriers to human security: demographic trends and access to social services (health, education) and discussed as components of human security: (a) protection of physical integrity from external and internal threats to human security; (b) meeting basic needs; (c) coping with contingencies and emergencies; and (d) participation in public life. In his proposed framework for achieving human security in the Arab world Chourou (2005: 83–103) argues that "human security must become an innate right of every citizen". As a key issue for achieving human security he pointed to the environment "to stop the advancing desert, rehabilitate agricultural land and improve the productivity of arable land" (Chourou, 2006: 86). He called for overcoming the ownership, the opportunity and the knowledge deficit.

An UNESCO conference in "Human Security in the Arab States" in Amman (14–15 March 2005) concluded that freedom from fear requires "a strict adherence to the rule of law" at the international and national level that is often "non-existent or insufficiently respected" in the Arab region. The conference suggested that the effective participation of citizens to education, health services, and jobs must be guaranteed to meet their basic needs. This implies that the "concept of human security and its underlying values of solidarity, tolerance, openness, dialogue, transparency, accountability, justice, and equity should be widely disseminated in societies" (Chourou, 2005: 101).

Most of the literature on human security and Israel, deals with the Israeli-Palestinian conflict. Typical of the many efforts by the international community to make a positive contribution to human security has been a Japanese contribution of a package for humanitarian assistance and state-building by the Palestinians by launching a "confidence-building initiative in promoting dialogue between the Israelis and the Palestinians" through a scheme of "grant assistance for grass-roots human security projects", including "cooperation in the field of environment between the Israeli government and the Palestinian Authority". The projects include humanitarian assistance (US$12.9 million), assistance for reforming the Palestinian authority (US$7.85 million), confidence building (US$1.5 million) that includes a joint Israeli-Palestinian project to improve the waste disposal of local governments and assistance for confidence-building between Israelis and Palestinians through "grass-roots human security projects."[18]

[18] See: <http://www.mofa.go.jp/region/middle_e/peaceprocess/measure0211.html>

In a research project of the Program on Humanitarian Policy and Conflict Research (HPCR) at the Harvard University School of Public Health on "Gaza 2010: Assessing Human Security Needs in the Gaza Strip at Harvard University" Claude Bruderlein[19] assesses

> the current human security situation in the Gaza Strip, to evaluate the projected public needs of the Palestinian population …, and to facilitate both intra-Palestinian and regional dialogue on human security issues …. In co-operation with the Palestinian Authority and other Palestinian institutions, HPCR plans to map projected public needs in five human security sectors – education, employment, environment, health services, and housing – and to analyze their implications for the next five years (from 2005 to 2010). … The results will be compiled in a report providing a Human Security Assessment for the Gaza Strip.

Contributing to this project, Ismail Lubbad analyzed the situation in Gaza after the Israeli withdrawal. He addressed demographic and socioeconomic trends and major challenges and common objectives for human security to improve the long-term planning for public services through research, capacity-building activities and dialogue.[20]

From an Israeli realist perspective, Gerald M. Steinberg (2004) offered a critique of the human security approach to arms control addressing its consequences and discussing questions raised by this approach. From his perspective "the basic constituents of the human security approach – individuals and NGOs – lack legitimacy".

> A Hobbesian world … in which conflict and hatreds are endemic – the human security approach to arms control cannot replace the centrality of nation states and the strategy of deterrence. … The attempt to turn the human security approach into the foundation for nuclear and other forms of disarmament is based on the perilous hope that "the security of the individual" can replace "the traditional unit of security—that of the state."

> The concept of security is inseparable from modern nation states, which provided the only protection from a highly anarchic environment. No reliable system of regional commerce was possible without "hard" security, and the centralized police powers of the state were essential in overcoming these obstacles. Post-nationalist ideology … is a recipe for yet more catastrophic warfare, resulting from the false belief that the state and deterrence have become irrelevant. … In a state of anarchy, the legitimate sovereign state

[19]See: https://webapps.sph.harvard.edu/cfdocs/worldmap/view_faculty.cfm?ID=984

[20]See: http://www.peacecenter.sciences-po.fr/journal/issue2pdf/lubbad_ismail.pdf#search=%22 human%20security% 2C%20Israel%2C%22

> and the deterrence that is provided by defense forces remain the only credible insurance. …In regions characterized by deep hatred and protracted conflicts, and where freedom has yet to be achieved for most people, the attempt to erase the security provided by deterrence and defense violates the basic rule – first, do not harm. Citizens of states whose survival is threatened are not going to entrust their core security requirements to unaccountable and often biased NGOs or international bodies.[21]

Steinberg reflects the Hobbesian thinking on the prevalence of "national security" in Israel that is shared by most governments in the region (Kam, 2003; Selim, 2003).

4.3. HUMAN SECURITY ISSUES IN THE ARAB WORLD

As the only country in the Middle East and in the Arab world, Jordan has been a member of the HSN and it hosted the Third Ministerial Meeting in Petra (Jordan) on 11–12 May 2001.[22]

With Canadian support a Regional Human Security Centre was set up in Amman that has organized many regional and national conferences since 2000 promoting the concept and many agenda items of the HSN, regionally and especially within the Arab world.[23] The Centre published two books: *Gender*

[21]See: Gerald M. Steinberg, Resolved: Human security should be the fundamental basis for multilateral disarmament and arms control negotiations. Presentation at the UNIDIR 25th Anniversary debate, November 23 2005, Geneva, Palais de Nations.

[22]"The meetings discussions considered the relationship and linkages between human security and human development. ... Ministers and representatives also underlined that promoting human development through the alleviation of absolute poverty, providing basic social services for all and pursuing the goals of people-centered development, is necessary for building human security. … [They] expressed concern at the increasing levels of insecurity faced by children under conditions of intense conflict and violence, particularly in the Palestinian territories." See chair's summary at: http://www.humansecuritynetwork.org/docs/Petrach_summary-e.php

[23]See: http://www.id.gov.jo/human/activities2000/activ2000.html; on: "Human Security in the Arab States" (March 2005 with UNESCO); "The International Criminal Court and the Arab World" (February 2005 with International Criminal Law Network (ICLN); "Small Arms and Light Weapons Research in the Middle East and North Africa Region" (2004 with Small Arms Survey); "Rights, Pluralism and Human Security: Putting Ideas into Practice" (2004); "The Amman Seminar on Military and Humanitarian Issues Surrounding the Ottawa Convention" (2004); Regional Training Workshop for Judges and Lawyers on Human Rights and Human Security (2004); "Tolerance Values: towards Human Security" (2003); "Annual Regional Network Workshop on How to Stop the Use of Children as Soldiers" (2003); Regional NGO Network Training on: Rights Based and Capacity Building Initiative on Children Affected by Armed Conflict (2003); "The UN PoA to Prevent, Combat and Eradicate the Illicit Trade in SALW in All its Aspects in the Arab Region: Successes and Challenges" (2003); "Participation of Arab Women in the Political Life" (2003); "Management and Strategic Planning at NGOs"

and Democratization in the Arab World and *Small Arms and Light Weapons in the Arab Region: National and Regional Measure*.[24]

In May 2004, the Oxford Research Group (UK) organized "The Amman Roundtable on Human Security in the Middle East co-hosted by HRH Prince Hassan bin Talal in Amman, Jordan.[25] In February 2005 in Beirut an "Arab Partnership for Conflict Prevention and Human Security" (APCPHS) was founded that developed an agenda for civil society organizations within the region.[26]

The FoEME conducted a project on human security with a special focus on water. According to FoEME human security "must encompass notions of justice, personal safety and include basic human rights but just as importantly include notions of compassion, common understanding and trust," and they argue that "human security on many issues, … requires a commitment to a solution that transcends political boundaries." They argue that water can be both a source of conflict as well as a "catalyst for dialogue".[27] Bromberg and Qumsieh (2004) proposed to advance "human security through the sharing of water perspectives in the Middle East". Since 1994, FoEME have cooperated on "human security issues in the broader sense", focusing "on water issues, highlighting water security issues – water supply and water pollution while promoting sustainable water use and understanding between cross-border communities."

This joint bottom-up approach of Israelis, Palestinians, and Jordanians who have cooperated in the framework of ICPRI and FoEME reflects a different notion of security that has shifted the referent from the state or own political group to the affected people. Many other joint activities, meetings, and publications of water specialists, such as the international conference on "Water for Life in the Middle East" (Shuval and Dweik, 2006, 2007) organized by the IPCRI, at which many of the participants from Israel, Palestine, Jordan, and Turkey

the Political Life" (2003); "Management and Strategic Planning at NGOs" (2003); "Preparing for the Middle East and North Africa (MENA) Region Contribution to the Implementation of the UN Programme of Action" (2003); "Traditional Cultural Practices and Small Arms in the Middle East: Problems and Solutions" (2002); "Regional Training Workshop for Judiciary and Security Staff on Human Rights and Human Security" (2002); "Building a Regional Network to Stop the Use of Children as Soldiers" (2002); "Curbing the Demand for Small Arms: A Middle East Seminar"(2002); "Gender and Democratization in the Arab Region" (2002); "Human Rights and Security" (2001); "Small Arms in the Arab Region: National and Regional Measures" (2001); "How to Stop the Use of Children as Soldiers" (2001); "National Workshop on Small Arms" (2001); "Children and Human Security" (2001); "Young Diplomats and Human Security Issues" (2000); "Pan-Arab Brainstorming Session" (2000); "Local Brainstorming Session" (2000).

[24]See at: <http://www.id.gov.jo/human/publications/publications.html>

[25]See at: http://www.oxfordresearchgroup.org.uk/publications/briefings/ammanreport2.pdf

[26]See details on this initiative at: http://www.gppac.org/page.php?id=87; and on the action plan at: http://www.gppac.org/page.php?id=958

[27]See at: http://www.foeme.org/projects.php?ind=54

emphasized that they believed cooperation between their respective countries was not only desirable but essential. However, the "spillover" from this manifold successful functional cooperation among experts and NGO representatives to the level of high politics has been limited. A Hobbesian understanding of security prevails there based on military power.

5. Sectorializing Security: Water, Food, and Health Security Concepts

The UNDP Report (1994) pointed to two sectoral concepts: "Food security" (Brown, 2004; FAO, 1996, 2005; Worldwatch Institute, 2005) and "health security" (Chen, 2004; Chen and Narasimhan, 2002; Kristoffersson, 2000; WHO, 2002) but not to "water security",[28] a concept that was launched at the first World Water Forum in The Hague in 2000. All three sectoral concepts can be analyzed from the perspective of three different referent objects: (a) the perspectives of international organizations ("institution-centered"); (b) of nation states ("state-centered"); and (c) of the human being or humankind ("people-centered"). Each of these three referents implies different policy agendas. Also the food and health security agendas of the developed and developing countries substantially differ.

5.1. WATER SECURITY

The "water security" concept emerged in the 1990s and has since been widely used by scientists, NGOs, and government officials. "The Ministerial Declaration of The Hague on Water Security in the 21st Century"[29] stated that water security required that:

> freshwater, coastal and related ecosystems are protected and improved; that sustainable development and political stability are promoted, that every person has access to enough safe water at an affordable cost to lead a healthy and productive life and that the vulnerable are protected from the risks of water-related hazards.

Providing water security has gradually evolved in a process of broad global participation by experts, stakeholders, and government officials that has profited from contributions of the World Water Council, its "World Water Vision"

[28] See: Water Security in the 21st Century. Ministerial Declaration, Second World Water Forum, The Hague, 22 March 2000, para.3, available at: http://www.thewaterpage.com/hague_declaration.htm; Ministerial Declaration, Third World Water Forum, Kyoto 23 March 2003, para.11, available at: http://www.mofa.go. jp/policy/environment/wwf/declaration.html

[29] See at: http://www.thewaterpage.com/hague_declaration.htm

process, from the World Commission on Water in the 21st Century and the "Framework for Action" by the Global Water Partnership. The "Ministerial Declaration" pointed to these main challenges:

1. *Meeting basic needs*: to recognize that access to safe and sufficient water and sanitation are basic human needs and are essential to health and well-being, and to empower people, especially women, through a participatory process of water management.
2. *Securing the food supply*: to enhance food security, particularly of the poor and vulnerable through the more efficient mobilization and use, and the more equitable allocation of water for food production.
3. *Protecting ecosystems*: to ensure the integrity of ecosystems through sustainable water resources management.
4. *Sharing water resources*: to promote peaceful cooperation and develop synergies between different uses of water at all levels, whenever possible, within and, in the case of boundary and trans-boundary water resources, between states concerned, through sustainable river basin management or other appropriate approaches.
5. *Managing risks*: to provide security from floods, droughts, pollution, and other water-related hazards.
6. *Valuing water*: to manage water in a way that reflects its economic, social, environmental, and cultural values for all its uses, and to move towards pricing water services to reflect the cost of their provision. This approach should take account of the need for equity and the basic needs of the poor and the vulnerable.
7. *Governing water wisely*: to ensure good governance, so that the involvement of the public and the interests of all stakeholders are included in the management of water resources.

The measures for coping with these challenges are based on the integrated water resources management (IWRM) concept that:

> takes account of social, economic and environmental factors and integrates surface water, groundwater and the ecosystems through which they flow. It recognizes the importance of water quality issues. In this, special attention should be paid to the poor, to the role, skills and needs of women and to vulnerable areas such as small island states, landlocked countries and desertified areas.

Based on a broad process of cooperation involving the government, citizens, and other stakeholders the ministers made many specific policy commitments for water security.[30]

The concept of "water security" has also been widely used – but hardly defined – within the UN system, especially by the World Water Assessment Program (2001) hosted by UNESCO that published a study *Water Security: A Preliminary Policy Progress since Rio*[31] and two World Water Development Reports: *Water for People. Water for Life* (UNESCO, 2003)[32] and *Water a Shared Responsibility* (2006)[33] in line with the first principle of the Rio Declaration that "human beings are at the center of concerns for sustainable development". UNESCO has analyzed the linkage between "potential conflict" (PC) and "cooperation potential"(CP) in the context of its PC-CP program:[34]

> PC-CP was created in order to help define and deal with problems before they result in serious conflicts and develop a momentum of their own; technical fact-finding and low-level negotiation in river basin organizations and commissions are often the best way to do this. Two of the precepts upon which cooperation is based are:
>
> - Building an atmosphere of trust is central to successful strategies for cooperation. How this can happen depends on many factors, from the internal divisions that affect governmental policies to the incentives offered by the international community.
> - Interstate bodies such as river basin commissions are of great value in that process, helping to bypass political roadblocks and achieve sound technical understanding on which decisions can be founded. …

During its first phase (2001–2003), PC-CP focused on international water conflicts that could cause "tension or even open conflict between sovereign states". I tried to answer the question: "how can political will, public participation, and institutional investment avoid conflicts and achieve cooperative basin management?" Its objective is to seek conciliatory ways to reach solutions for the management of shared water resources.

PC-CP has drawn extensively on case studies and work in the fields of law, engineering, and peace studies, focusing on: (a) how conflicts escalate and how the vicious circle can be broken; (b) how cooperation develops in different

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[30]See at: http://www.thewaterpage.com/hague_declaration.htm
[31]See text at: http://www.unesco.org/water/wwap/wwdr/water_security.pdf
[32]See text at: http://www.unesco.org/water/wwap/wwdr/table_contents.shtml
[33]See text at: http://www.unesco.org/water/wwap/wwdr2/table_contents.shtml
[34]See at: http://typo38.unesco.org/en/projects-and-partnerships/conflict-resolution.html

situations; and (c) what practical steps are necessary to assist this process. Under a joint initiative with Green Cross (GCI) on "Water for Peace," UNESCO has published between 2001–2003: (a) 19 papers on the legal, technical, and diplomatic tools available for the anticipation and the resolution of water conflicts, and on lessons learned from historical experiences; (b) 9 case studies drawing lessons from the root causes of conflicts, and the successful cooperation in water resources management; and (c) 5 educational modules addressed to a large target audience with an interest in water management.[35]

A synthesis study by Cosgrove (2003) traces the trends in both conflicts and cooperation over water resources from the beginnings of human civilization to the modern day challenges of big dams, climate change, and mega-cities without ever defining "water security" or linking it with human security.

> The report clearly shows that there has always been competition, and sometimes conflict, over water since the earliest human settlements; but what matters most in preventing conflicts is a community's capacity to cope with and adapt to water stress, and the institutions available to them to deal with competition between users. Both our capacities and institutions have evolved over the centuries, but while the need to develop the technical means to address shortages through diversion or storage of water has always received attention and resources, less focus has been placed on human capacity-building and the development of effective institutions to manage water wisely and equitably. This neglect of the institutional side is largely responsible for spawning the water management crisis experienced across the world today.[36]

From a Hobbesian perspective of a military strategist, Berman and Wihbey (1999) in "New Water Politics of the Middle East" claimed that:

> The crisis over water in the Middle East is escalating. Despite existing agreements, dwindling resources – increasingly affected by pollution, agricultural/industrial initiatives and population growth – have elevated the strategic importance of water in the region. For Middle Eastern nations, many already treading the razor's edge of conflict, water is becoming a catalyst for confrontation – an issue of national security and foreign policy as well as domestic stability. Given water's growing ability to redefine interstate relations, the success of future efforts to address water sharing and distribution will hinge upon political and strategic approaches to this diminishing natural resource.[37]

[35]See at: http://webworld.unesco.org/water/wwap/pccp/cd/pccp_publications.html

[36]See Report at: http://webworld.unesco.org/water/wwap/pccp/cd/pccp_publications.html

They argued that “only under a new strategic architecture can the normalization of growing water conflicts become a realistic option.” They called for “the creation of an alliance system based on the use of strategic resources in a rational and equitable manner may allay current fears and facilitate interaction on the basis of mutual benefit.” Furthermore, “since extensive water planning proposals will necessitate the establishment of pipelines and energy grids stretching across borders, a political and military structure that can ensure the safety and security of these carriers … will be a prerequisite to effective water sharing.” They proposed, “movement towards strategic water security could be assisted through the integration of water as a distinct element of coordination among the burgeoning strategic alliances taking shape in the region. Creating a solid political-military framework on water issues … could initiate a broad range of collaborative ventures.”

The relevance of the *water security* (Allan, 2003) concept in the Middle East has been mentioned in the partnership between US EPA and the Israeli Ministry of National Infrastructure in a statement of intent of 19 July 2005 in which both parties agreed “to improve water supply system security in the United States and Israel.” Joint projects could “include work on contamination warning systems … field testing of sensor technologies, water supply risk assessment and management, and emergency response.”[38]

While “water security” is conceptualized here from a “national security” perspective by protecting water against terrorist attacks, in most scientific and political contributions “water security” in the Middle East or MENA region is conceptualized from a “human security” perspective often focusing on its environmental dimension and its relationship with food and health security in the region.

5.2. FOOD SECURITY

Concepts of food security have evolved since the 1970s (Clay, 2002), when the World Food Summit (1974) defined it “in terms of food supply – assuring the availability and price stability of basic foodstuffs at the international and national level: ‘availability at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset

[37]See: Berman, Ilan; Wihbey, Paul Michael, 1999. The new water politics of the Middle East, in: *Strategic Review*, Summer.

[38]See at: http://yosemite.epa.gov/opa/admpress.nsf/f781d66a5ac5c4358525702100561e8d/7940440c3adb1b13852570440068270e!OpenDocument; on US EPA’s water security efforts see at: http://cfpub.epa.gov/safewater/watersecurity/index.cfmthat focus on vulnerability assessments, emergency, incident planning, security enhancements, legislation and directives.

fluctuations in production and prices'" (FAO, 2006: 1). In 1983, FAO adopted a definition based on a balance between the demand and supply side: "assuring that all people at all times have both physical and economic access to the basic food that they need" (FAO, 1983, 2006: 1). For food security, a food system should be characterized according to Barraclough (1991) by the following:

- The capacity to produce, store, and import sufficient food to meet basic needs for all population groups
- Maximum autonomy and self-determination (without implying self-sufficiency), which reduces vulnerability to international market fluctuations and political pressures
- Reliability, such that seasonal, cyclical, and other variations in access to food are minimal
- Sustainability, such that the ecological system is protected and improved over time
- Equity, meaning, as a minimum, dependable access to adequate food for all social groups

An "institution-centered food security" concept has been widely used by the FAO (FAO, 1996: 265-266) that defined food security "as the access for all people at all times to enough food for an active, healthy life." The three key ideas underlying this definition are: (1) the adequacy of food availability (effective supply); (2) the adequacy of food access, i.e. the ability of the individual to acquire sufficient food (effective demand); and (3) the reliability of both. Food insecurity can, therefore, be a failure of availability, access, reliability or some combination of these factors.

The new definition "has enabled policy responses focused on the promotion and recovery of livelihood options" (Chambers and Conway, 1992) that have been

> increasingly applied in emergency contexts and include the concepts of vulnerability, risk coping and risk management. In short, as the link between food security, starvation and crop failure becomes a thing of the past, the analysis of food insecurity as a social and political construct has emerged (Devereux, 2000). More recently, the ethical and human rights dimension of food security has come into focus (FAO, 2006: 1).

Food security does not imply self-sufficiency in food, a goal that is unachievable in many arid and semiarid regions with very high population growth. Food security requires both sufficient food availability (supply) and access to satisfy the demand.[39] Salih (2007) has pointed to different concepts of food security and governance in the North and South that reflect different agendas of food safety ("food that kills") and food scarcity ("famine that kills").

The "food security" concept has been widely used dealing with food issues in the Middle East and in the MENA region (Lofgren, 2003; FAO, 2005). According to Diaz-Bonilla et al. (2000) the MENA region was highly food-insecure due to the declining self-sufficiency rates in cereals and was negatively influenced by political instability and conflicts. Between 1983–1987 and 1995–1999, in Jordan food production stagnated and household consumption per capita declined by –2%. The calorie consumption between 1973–1977, 1983–1987 and 1993–1997 was above 3,000 per capita per day in Egypt, Israel, Lebanon, and Syria but below for Jordan. Between 1983–1987 and 1995–1999, the self-sufficiency in wheat rose for Syria by 51%, Egypt by 25.1%, and Lebanon by 5.2%, while it dropped for Jordan by –8.2% (Lofgren and Richards, 2003: 30–35).

Food security in Israel was assessed in 2003 study by the Brookdale Institute (Smokler Center) with the Ministry of Health, the National Insurance Institute, the Ministry of Social Affairs, and the Forum to Address Food Insecurity and Poverty in Israel.

> The study found that a significant portion of the population (22%) was food insecure and 8% was food insecure with hunger. These population groups reported problems of access to adequate and appropriate food, attributable to economic difficulties. In addition, the National Insurance Institute of Israel reported that 30% of Israeli children are below the poverty line, underlining the urgency of efforts to eradicate food insecurity among children. National school feeding programs have been discussed as one means of alleviating food insecurity among children, with the added benefit that it serves as a platform for nutritional education. … Issues such as eligibility, equity, food nutritional quality and safety will need to be resolved before wide scale implementation of school programs will be able to alleviate child food insecurity.[40]

[39] In preparation for the *World Food Summit* of 1996, the FAO 1996. Published three volumes on food security that dealt with food insecurity and with the inadequacy of food production to meet nutritional needs.

[40] See at: http://nutrition.tufts.edu/conferences/childhood/summary.htm; *Child Nutrition Initiative in Israel and Palestine:* Meeting Report, Beer Sheva, Israel, February 7-9, 2005, Tufts University, Ben Gurion University and Al Quds University.

With rising poverty and unemployment, the food security situation – in terms of access to sufficient food – has been severe for Gaza and the West Bank[41] and has worsened since the year 2000.[42]

> FAO in cooperation with the World Food Program (WFP) and the United Nations Relief and Works Agency (UNRWA) undertook an assessment of the food and nutrition situation in the West Bank and Gaza Strip (WBGS) February through July 2003. … The assessment concluded that though food is generally available, access is limited due to physical (curfews, closures) and economic reasons (high unemployment, depletion of resources, exhaustion of coping strategies and strained social support networks). … Households have until now been able to manage in the difficult circumstances albeit with dwindling resources and increased vulnerability to shocks. However, resilience has been greatly weakened, vulnerability increased and coping mechanisms severely strained ….
>
> With rising poverty and unemployment, the food security situation has considerably deteriorated …, with four out of ten Palestinians food insecure. Food insecurity is a reality for 1.4 million people (40 percent) and a near constant worry for an additional 1.1 million people (30 percent) who are under threat of becoming food insecure should current conditions persist. People's physical access to food and farmers' physical access to the inputs and assets to produce food have been severely affected by restrictions on the movement of people and goods and the damages to personal property. The massive loss of jobs, earnings, assets and incomes sharply reduced economic access to food with real per capita income decreasing by half since 1999 and resulting in six out of ten people falling below the US$2.10 per day poverty line. The exhaustion of coping strategies and the inability of the social safety net to adequately protect have resulted in reductions in the quantity and quality of food consumed. These … factors … place the Palestinian population at-risk of being food insecure.

This increasing food insecurity directly affected the health security of Israelis and Palestinians. A joint study by three universities: Tufts (USA), Ben Gurion (Israel), and Al Quds (Palestine) concluded in February 2005 at a conference in Beer Sheba:

> In summary, the levels of food insecurity are on the rise in both Israel and Palestine, more so in Palestine. There is not enough information on the effectiveness of the existing national level social safety nets in combating

[41] See at: http://www.fao.org/docrep/006/J1575E/J1575E00.HTM

[42] See at: http://nutrition.tufts.edu/conferences/childhood/summary.htm

food insecurity. There is a need for research on food safety nets, their scale of operations and their effectiveness in both these countries.[43]

While food security partly relies on water security, both aspects of food security, *food safety* and *food scarcity* have a direct impact on the health security of the people.

5.3. HEALTH SECURITY

The "health security" concept is closely related to all five security dimensions. Within the *environmental* dimension of security ("ecological security") it is closely linked with "water security" (referring to the health problems that are generated by *water scarcity*, e.g. drought, heat waves), *abundance* (flash floods and inundation), and by *degradation* and *pollution* (water-related diseases). In the *societal* and *economic* dimension of security, health security refers to totally different discourses in the North (health reform, affordability of public health services for aging societies partly based on solidarity principles) and in the South (bringing basic health services to the poor and most vulnerable to both diseases and water related hazards).

The health security debate has also acquired a *political* dimension, e.g. due to the use of economic sanctions (e.g. on the health of children in Iraq), and the prevention of scientific assessments of the impact of enriched uranium projectiles used in the second Persian Gulf war (1991, Haavisto, 2003; UNEP, 2003, 2004) and a *military* dimension on the impacts of wars (war and post-war periods) but also on the health of combatants and the civilian population (by the use of conventional and mass destruction weapons that do not discriminate) and recently of the fear that terrorists may use biological and chemical weapons indiscriminately thus threatening the survival of civilians in the urban centers of the developed world.

The "health security" concept has also been used from the perspective of international organizations (WHO), of nation states and from a human security perspective. Health security (WHO) requires a guarantee of accessible and affordable health care to all. While the analysis of the different "health security" concepts and strategies of the World Bank group and of WHO and UNDP is either "institution-centered" or "state-centered" closely linked to the role and initiatives of states in these intergovernmental organizations, the practice of the health official and physician in the field is primarily "human-centered" focusing on patients. WHO has used an "institution-centered" concept as *Global Health Security* (Epidemic Alert and Response)[44] for a global partnership: (a) to contain

[43] See at: http://nutrition.tufts.edu/conferences/childhood/summary.htm
[44] See details at.http://www.who.int/csr/about/en/

known risks, (b) to respond to the unexpected, (c) to improve preparedness?[45] The WHO also launched a "global health security initiative",[46] and appointed a *Strategic Advisory Committee for Global Health Security* to assist advancing its strategy on global health security whose tasks are: (a) to provide strategic advice on scientific and technical issues related to the goals and objectives of the Communicable Disease Surveillance and Response (CSR) program for global health security; (b) to provide an independent evaluation at a strategic level of the CSR portfolio of activities, including strategic emphasis and priority-setting of the program for global health security; and (c) to identify and advise on new scientific opportunities, international initiatives and collaboration appropriate to the CSR program. WHO's Department on CSR aims at three strategic directions for global health security through International Health Regulations (IHR):

1. *Contain known risks*: of leading epidemic, emerging diseases by global surveillance and response networks for diseases, e.g. influenza, meningitis, plague, SARS, Ebola, Lassa and yellow fever;
2. *Respond to the unexpected*: CSR's epidemic intelligence system gathers & verifies outbreak information daily, coordinates international responses under its Global Outbreak Alert & Response Network.
3. *Improve preparedness*: CSR supports strengthening of national capacity for alert and response. The WHO office in Lyon, France, is dedicated to further improving laboratory infrastructure, including biosafety and epidemiology capacity in developing countries and to strengthen national preparedness for deliberate or accidental release of biological agents to cause harm.

Major actors to enhance health security are the WHO and its affiliates, humanitarian organizations (OCHA, ECHO) and development organizations including NGOs.

In an input to the CHS, Chen and Narasimhan (2002) have contributed a human security perspective on health by arguing that "good health and human survival are ultimate goals of any human security agenda." Three linkages have challenged health security: (a) conflict and violence, (b) global infectious diseases (HIV/AIDS, SARS), and (c) poverty and inequity. Poverty-linked infectious diseases and malnutrition were responsible for two third of all deaths what is also reflected in a North-South divide. Among the remedies the suggested better protection, prevention, and early warning of diseases as core health functions, risk pooling, and health insurance, new cooperative partnerships and

[45]See details at: http://www.who.int/csr/about/sac/en/index.html
[46]See at: http://www.hc-sc.gc.ca/ahc-asc/media/nr-cp/2005/2005_stmt-glob_initiat_e.html

global institutions and policies. They argued against the close linkage of the WHO infectious disease unit with national security, stressing that "human security should underscore the ultimate dignity of individuals that should not be compromised under national security" (Chen and Narasimhan, 2002: 11).

While the health security concept has not yet been widely used in the Middle East and in Israel and Palestine in particular, health security issues have been assessed by both national and international reports. On 27 April 2005, the US-based RAND Corporation recommended for water and health security of an independent Palestinian state:

> Today Palestinians have only half of the minimum amount of water per person established by the World Health Organization. Coping with a severe and worsening water shortage will require a combination of measures to enhance supply and restrain demand. One way to provide Palestinians with enough water to meet World Health Organization standards would be for Israel and Palestine to renegotiate the allocation of existing water resources. Removing water from aquifers beyond sustainable limits must be halted to avoid creating worse shortages. Increased efficiencies, water re-use, and irrigation management should be used to deal with part of the water shortfall. The international community should be ready to finance construction of desalinization plants and infrastructure improvements. … Health system planning and policy development should be better integrated and planned. Public and primary health care also need to be expanded to include programs for immunizations, nutrition, preventing and treating chronic and non-infectious diseases, and treating developmental and psychosocial conditions.[47]

The Union of Palestinian Health officials have been highly critical of the impact of the occupation on the health situation in Palestine.[48] In September 2005, the Japan International Cooperation Agency (JICA), United Nations Children's Fund (UNICEF), and the Palestinian Ministry of Health (MOH) have launched

> a new partnership for improving maternal and child health in Palestine. … JICA started a new 3 year technical cooperation project: 'Project for Improving Reproductive Health with a Special Focus on Maternal and Child Health in Palestine' to improve health among women and children in Palestine. Maternal and Child Health (MCH) services and management are upgraded through the capacity development of the medical and administrative staff.

[47]See at: http://www.rand.org/news/press.05/04.27.html
[48]See at: http://www.upmrc.org/content/health/main.html

> Grass-root health education activities such as workshops and home visit are also conducted to improve the awareness and health seeking behaviors among women and children, which include the development and promotion of the MCH Handbook. …This Project is implemented as a part the JICA Development Program in Jericho and the Jordan River Rift Valley which help ensure that municipal government and community people can take active part in improving the health and quality of life in their community.[49]

The health security of both Israelis and Palestinians, as well as that of Israel's other Arab neighbors has been affected by the ongoing violent conflicts since the breakdown of the peace process in 2000. Logistical problems involving the transfer of Palestinian patients to hospitals in Israel offering specialist services otherwise unavailable to them, have been a cause of particular friction.

6. Gender Security and a Combined HUGE Concept

The term "gender" describes the state of being male, female, or neither. In the social sciences, "gender" is used in contrast to biological sex, to emphasize a social, cultural, or psychological dimension. *Gender studies* investigate the nature of sex and gender in a social context. As a social concept, *gender* has been increasingly used since the 1950s to distinguish a social (or gender) role and/or personal (or gender) identity as distinct from biological sex. A person's gender has legal significance, e.g. for the retirement age in pension systems or with regard to sexual offences (e.g. rape). The role of women and gender issues are regarded as important for the success of development programs.[50]

Northern and Southern concepts of "gender" have differed.[51] While Northern feminists (Tickner, 1992, 1995, 1996, 1999, 2002; Hudson, 2005) have addressed the male – female divide in security analysis, authors in developing countries (Mies and Shiva, 1993; Oswald, 2001) have used a wider gender concept (including children, old and indigenous people) and ecofeminism (Shiva, 1998, 2002, 2003, 2007; Shiva and Mies, 1995). Gender has been an object of scientific analyses from different perspectives of epistemological, empiricist, postmodern, and standpoint feminism. Oswald (2007) has also distinguished among four phases of gender security studies focusing on: (1) analysis of identity and social representation; (2) postmodern feminism and gift economy; (3) environmental

[49]See at: http://domino.un.org/UNISPAL.nsf/3822b5e39951876a85256b6e0058a478/028144cae82be5c58525708f00469cbe!OpenDocument

[50]This definition is taken from *Wikipedia* at: http://en.wikipedia.org/wiki/Gender

[51]See on: Gender, Security and Peace, at: http://uit.no/statsvitenskap/humansecurity/7?SubjectId=1&From=0>; at: < http://www.unu.edu/unupress/unupbooks/uu37we/uu37we04.htm

degradation and ecofeminism; and (4) social movements. For Hoogensen, “gender is a part of the security dynamic, particularly through societal security and the articulation of identities. Gender articulates security needs that demand a response ... by the state, by communities, by individuals.”[52] According to the *Nairobi Forward-Looking Strategies for the Advancement of Women* (2003):

> Peace is promoted by equality of the sexes, economic equality and the universal enjoyment of basic human rights and fundamental freedoms. Its enjoyment by all requires that women be enabled to exercise their right to participate on an equal footing with men in all spheres of the political, economic, and social life of their countries, particularly in the decision-making process, while exercising their right to freedom of opinion, expression, information and association in the promotion of international peace and cooperation.[53]

Oswald (2001) suggested a widened HUGE that combines

> an extended gender concept including children, elders, indigenous and other minorities with a human-centred focus on environmental security challenges, peace-building and gender equity. ‘Gender security’ is considering livelihood, food security, health care, public security, education and cultural diversity. This concept analyzes the patriarchal, violent and exclusive structures within the family and society, questioning the existing process of social representation-building and traditional role assignation between genders.
>
> HUGE reorients “human security” to include equity and development issues through social organization, specific governmental policies, private ethical investments and legal reinforcements. It aims at a socio-political participation of women, the young and elders. It focuses on gender discrimination, by widening the narrow male-female relationship of some feminist approaches.
>
> HUGE includes “environmental security” concerns where a healthy environment and resilience-building of highly vulnerable groups (especially women) can reduce risk impacts. For hazard prone areas, HUGE analyzes the potential of technical, financial and human support for reducing this vulnerability, enabling women and other exposed groups to reinforce their own resilience through bottom-up organization combined with top-down

[52]See at: http://uit.no/getfile.php?PageId=1410&FileId=293#320,48,Gender and security
[53]Cited by Hoogensen, at: http://uit.no/getfile.php?PageId=1410&FileId=292

> policies and tools able to guarantee effective early warning, evacuation, disaster help and reconstruction. … As non-violent conflict resolution is a central part of personal and social identity in a world where processes of unification and diversification are occurring faster than ever in the past, human beings have a basic necessity to simplify and to put order into complex realities through social comparison. ... In synthesis, HUGE integrates social, environmental, human, cultural and identity concerns, aiming at solidarity, resilience, participatory democracy, peace-building and equity in an increasingly insecure and risky world (Oswald et al., 2007).

Within the UN, the United Nations Development Fund for Women (UNIFEM) and United Nations International Research and Training Institute for the Advancement of Women (INSTRAW) work on women's issues, as well as a special advisor to the Secretary General, and an inter-agency network of gender focal points (IANWGE). Since 1976 UNIFEM has supported programs and strategies for women's human rights, political participation, and economic security, as well as women's empowerment and gender equality. INSTRAW addressed issues of gender in security sector reform. Several studies by UNIFEM and INSTRAW have focused on the role of women in war and peace-building (Rehn and Sirleaf, 2002).[54]

The *Beijing Platform for Action* (1995) established gender mainstreaming as a major global strategy for the promotion of gender equality, and this strategy was later defined in the ECOSOC Agreed Conclusions (1997/2). Building on these two mandates, many explicit mandates were established to mainstream gender into the work of the UN. Security Council resolution 1325 on "women, peace, and security" that was unanimously adopted on 31 October 2000 has since provided a political framework for women and a gender perspective on negotiating peace agreements, planning refugee camps, and peacekeeping operations, and reconstructing war-torn societies.[55] It mandates gender mainstreaming in the area of peace and security, with specific mandates for conflict resolution, disarmament affairs, electoral processes, health statistics, humanitarian assistance, and peacekeeping operations, and in other UN areas of work. The challenge now facing the UN system is to implement these mandates in order to ensure that attention to gender perspectives is an integral part of interventions in all areas of societal development.

While the Middle East conflict has seriously affected "women on both sides … – their security compromised, their health and lives and families threatened, their ability to function in a daily routine made increasingly difficult, and their

[54]For a list of studies see at: http://www.womenwarpeace.org/toolbox/osagiinventory.pdf

[55]See at: http://www.womenwarpeace.org/toolbox/toolbox.htm

economic stability undermined", a comprehensive report on "The Impact of the Conflict in the Occupied Palestinian Territory on Women" has focused only on the manifold impacts on the "gender security" of Palestinian women.[56]

In the Occupied Palestinian Territories (OPT) many gender-specific activities have been launched by the UNRWA for Palestine Refugees in the Near East , the Economic and Social Commission for Western Asia (ESCWA), the UNDP, the International Labour Organization (ILO), the Office for the High Commissioner for Human Rights (OHCHR), the World Food Programme (WFP), the FAO, the UNICEF, The Department of Public Information (DPI), the United Nations Conference on Trade and Development (UNCTAD), the World Bank, the United Nations Population Fund (UNFPA) and the World Health Organization (WHO).[57]

While manifold gender security issues with regard to the Middle East have been an object of political assessment by international organizations, human rights NGOs, and by social scientists, hardly any conceptual debate on gender security concepts has occurred within the region, neither in Israel nor in Palestine, Lebanon, Jordan, and Egypt. Adding a gender security perspective to the analysis of other soft security issues (environmental, water, food, and health) can provide a more sophisticated analysis of the impact and human costs of the Middle East conflict.

7. Conclusions: Addressing Environmental Security Challenges Related to Water, Food, Health and Gender in the Middle East

While there has been much reluctance in the Middle East – especially in Israel, Palestine, and Jordan – to extend the narrow militarily focused "national security" concept to "securitize" soft environmental, human as well as water, food, health and gender security threats, challenges vulnerabilities and risks, these widened security concepts have increasingly been used both by outside governments (e.g. environmental security by the USA; human security by Canada and Japan), international organizations (FAO, WHO, UNWRA; UNICEF) and also by institutes and environmental NGOs within the region.

So far this new thinking on environmental, human, water, food, health, and gender security has been ignored or rejected by the political and military elites and by the dominant Hobbesian mind-set of political realists and strategists in the Middle East. For them only the "nation state" remains the sole referent of security and military means in terms of power and deterrence (arms potential,

[56]See at: http://www.womenwarpeace.org/opt/opt.htm#country_team
[57]See at: http://www.womenwarpeace.org/opt/opt.htm#country_team

threat with and employment of force) the legitimate instruments to guarantee the "security" and the "survival" of the state.

The cost of this logic could be observed during the 5-week war in July and August 2006 between Israel and Hezbollah for the affected people when more than 1,000 persons died in Lebanon and Israel, more than 900,000 Lebanese lost their homes and 500,000 Israelis fled temporarily, when the environment was severely damaged by oil spills and forest fires on both sides. An assessment of the damages and costs of this war for environmental, human, water, food, health, and gender security may be useful.

Whether its impact will be widely felt among politicians and officials in the region most of whom still adhere to a "hard" or national security concept will depend on the willingness of the affected people to challenge this prevailing logic of their respective leaders. Nevertheless, a way must be found which will enable the political leaders, while not neglecting the "national security" needs of their own state or community, to take a broader view of what security means for their people.

However, whether and when bottom up initiatives by NGOs and social movements will be reflected in conceptual, political, and operational changes in government policies in the region depends on many factors within the region, especially also on the mood and the will of the affected people. The functional cooperation among water experts and officials from Israel, Palestine, and Jordan has been a sign of hope and a necessity for survival in a water stressed arid and semiarid region.

Whether and when this functional cooperation induces a positive "spillover" to the high political level remains to be seen in the future. There are many new emerging joint environmental threats, challenges, vulnerabilities, and risks as a consequence of global environmental and climate change that will affect all countries that cannot be countered with military means but only with cooperation – beyond all differences and conflicts.

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HYDRO-DIPLOMACY: OPPORTUNITIES FOR LEARNING FROM AN INTERREGIONAL PROCESS

ÚRSULA OSWALD SPRING[1]

Regional Centre of Multidisciplinary Study, National University of Mexico, Cuernavaca
El Colegio de Tlaxcala, Tlaxcala, Mexico
UNU-EHS, MRF Chair on Social Vulnerability, Bonn, Germany

Abstract: Comparative studies on water-scarce regions show structural similarities and differences on water cooperation through agreements among Israel, Jordan, and Palestine, as well as for the USA and Mexico. Both regions experience an increasing water stress due to demographic pressure, global environmental and climate change, competition between different water uses (agriculture and domestic vs. industrial and services), pollution. Both regions consist of a militarily, socially, and technically powerful upstream partner and unstable border conditions.

However, if water can be separated from other parts of regional conflict and negotiation can be implemented, progress can be made. Global geopolitical concerns will dominate over the management of natural resources. Within this framework, a *hydro-diplomatic negotiation process* is proposed, which operates simultaneously at the international, national, regional, and local level, offering the parameters of negotiation and financial support.

The other levels could bring processes of capacitating, rationalization, cooperation, common investment, and management of water, aquifer, and ecosystem restorations, wastewater collection, rainwater harvesting, sewage, new water development, and practices of reduction, but also reuse of treated water. Besides a top-down approach by governments and technicians, the bottom-up process induces a different culture of water, stimulates the local water market, the reduction and

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saving of water an the transmission of agricultural water to higher valued economic processes without polluting the scarce resource. The interrelationship between both facilitates consolidating human, gender, and environmental security (HUGE) also for highly marginal social groups such as women, children, and elders living downstream, thus enabling them to develop a long-term strategy of sustainability in the region.

The hydro-diplomacy model provides a powerful tool to organizational processes at all levels, reducing the demand of the vital liquid through rational management and increasing the supply by diversification of uses and reuses. Above all it shows that a domestic and cooperative infrastructure and a long-term peaceful coexistence process with cooperation is more effective than a conflictive behaviour for water allocation, use and reuse. A holistic management of this scarce, but indispensable resource is needed linked to a rational management of the ecosystem that is being threatened by natural and anthropogenic processes.

Keywords: hydro-diplomacy; non-violent water conflict negotiation; water scarcity; functional cooperation and long-term coexistence; clarification of property rights; and basic human rights for water

1. Introduction

During the last century population has tripled and water use has increased six times. Civilizations have grown around water facilities and disappeared due to drought or hydro-meteorological hazards. Waterways were used for transport, trade, agriculture, and livelihood. Due to water shortage, engineers have transported water across long distances or have constructed large dams, affecting ecosystems, destroying water basins and resettling indigenous people. However, water scarcity is growing due to physical and economic stress. Today, 3 billion people lack a basic sanitation system and 1 billion are missing a direct and sufficient access to drinking water. The effects of unsafe water are water-borne and vectored illnesses; and every year 500 million get sick from these diseases and millions die, especially children due to diarrhoea. Daily millions of poor people struggle for their food, and the poorest of the poor, the highest vulnerable are women and children in the Third World, some are also facing HIV-AIDS.

Access to safe and sufficient water for drinking, cooking, hygiene, and growing some crops for self-sufficiency are basic human rights, which are not guaranteed for half of the world population. What is happening with the industrial, the technological and the communication revolutions, when humanity, techniques and policy is still not able to offer these minimal human needs? Which are the economic, social, and ethical limits avoiding that science and technology can be reoriented to satisfy these basic needs?

With a comparative approach this chapter offers some possible solutions for water scarcity. The paper focuses on the region of the Middle East, particularly the area with the highest water stress in the Jordan Valley, comparing it with some reflections from another water-scare region: the border between Mexico and the USA. Nevertheless, the historical, political, and social situation is different; both regions are located in an arid and semi-arid ecosystem. Both have neighbours with different political and military strength and both must cooperate to find integral solutions when confronted with global and climate change that are both aggravating the existing water scarcity and pollution in the respective region.

This chapter analyses first the concepts of human and environmental security, conflicts, risks, threats, and social vulnerability and resilience, creating a complex framework for water analysis. It explores the ability of humans to deal with challenges such as water stress, disasters, desertification, and pollution. In the second part, it reviews the threats and hydro-meteorological risks in Mexico and relates them to poverty and marginalization. Later, with regard to the water dispute between the USA and Mexico an integral *hydro-diplomatic strategy* is suggested which intends to resolve the tensions between both countries without violence, especially in a situation where water scarcity is growing. This strategy may be adapted to other conflicts on natural resources in Mexico, as well as in other parts of the world and could offer the Middle East some starting points for the development of their own hydro-diplomatic approach.

2. Conceptual Approach on Conflicts, Human, Environmental and Gender Security, Hazards, Disasters, Risks, Social Vulnerability, and Resilience-Building

2.1. CONFLICTS

Conflicts are motors moving the world. They are present in each human and social relationship. The negative outcome is violence. There exists different theories for conflict management and peaceful conflict resolution (Rupesinghe, 1992; Glasl, 1994; Gandhi, 1997; Oswald, 2000, 2002, 2003, 2005; Reychler and Pfaffenholz, 2001; Saviñón, 2003; De la Rua, 2004), and there are several ways to resolve conflicts: socially, politically, and technically. Frequently, conflicts are postponed, transformed, manipulated, and its resolution is administered in little doses; but it is also possible to resolve them in aiming at the roots.

Postmodern thinkers (Martineau and Yates, 1984; Giddens, 1991, 1994; Butler, 1990; Alcoff and Potter, 1993; Habermas, 1995, 2000 Alcoff, 1996; Persram, 1994) argued that the growing inequality in geographical (North-South; rural-urban; desert-tropic; mountain-coast) and social terms (poor-rich; élites-dispossessed) has increased the contradictions between those who possess, have access to natural resources and commodities, education and power, and those without anything. Faced with a growing scarcity of renewable and non-renewable resources and the incapacity of multiple states to reduce social tensions and to guarantee a minimum necessary for the well-being of the marginalized population, debates on ethics of social equality have evolved. The United Nations (UN) has claimed that a minimal well-being as an inalienable right for life should be guaranteed for any person on the globe. Nevertheless, this individualist and Eurocentric approach (Preiswerk, 1985), does not take into account the common rights of indigenous societies (De la Rúa, 2004; Gaitán, 2004; Gil, 2004; Menchú, 2004). On the contrary, it takes for granted the theories of late capitalism, where the logic of the value of change is denying the logic of the value of use, which has functioned for thousands of years within traditional societies and is still partially operating in rural societies in Africa, Latin America, and Asia (Saruchera, 2005).

2.2. WIDENING SECURITY CONCERNS

After five decades of development the evaluation has shown poor results. In Latin America (CEPAL, 2004) at least two decades were lost, Africa has several failed states and Asia is still struggling against extreme poverty and avoidable illnesses. Confronted with this crude reality an increasing concern for development and security all over the world induced the UN to adopt the Millennium Development Goals (MDG, 2000). Earlier, the UN Program for Development (UNDP, 1994) had shifted from the traditional security concept, linked to nation-states and military activities, to a new concept directly related to people: *human security* as the functional equivalent to *human development*. For UNDP human security[1] focuses on life and human dignity instead on military threats and includes "protection from the threats of disease, hunger, unemployment, crime, social conflict, political repression and environmental hazards" (UNDP, 1994: 23; see also Brauch, 2005a, b). Military thinking and concepts have been substituted by progressive attitudes such as respect for, international human laws and human rights of the second and third stage, refugee protection, support for humanitarian aid in case of natural disasters and wars, development based on gender and social equity, and cultural diversity with religious freedom.

From a constructivist approach to security analysis trying to understand the linkages between different security approaches, the Copenhagen school systematized the links between several security approaches (Waever, 2000; Buzan et al., 1998). Møller (2003) criticized the narrow concept focused on *national security* and proposed an extended or widened concept of *societal security,* he labelled as "incremental"; a *human security* he described as "radical" and an *environmental security* he termed as "ultra-radical" (see Table 1). Going beyond the traditional realist approach of security definition of Wolfers (1962), the Copenhagen school distinguished between different referent objects (state, nation, societal groups, individuals, humankind, and ecosystems), and depending on the security concern the values at risk are sovereignty, national unity, survival and sustainability. With regard to security from whom or what the sources of threat were other states, nations, globalization and nature.

TABLE 1. Human, gender, and environmental security

Level of expansion	Determination Which security?	Mode of expansion Reference object Security of whom?	Value at risk Security of what?	Source(s) of threat Security from whom or what?
Without expansion	National security (political, military dimension)	The State	Sovereignty, territorial integrity	Other States, terrorism, sub-state actors, guerrilla
Increased	Societal security	Nations, social groups	National Unity, national identity	(States), Nations, Migrants, Alien cultures
Radical	Human security	Individuals (Humankind)	Survival, quality of life, cultural integrity	The State, globalization, nature, GEC, poverty, fundamentalism
Ultra-radical	Environmental Security	Ecosystem, urban and agricultural system	Sustainability	Nature Humankind
Trans-radical	Gender security	Gender relations, indigenous, minorities	Equity, identity, social relations	Patriarchy, totalitarian institutions (élities, governments, religions, culture), intolerance

Source: Bjørn Møller, 2003:279 and Úrsula Oswald, 2001, 2004

From a vulnerability perspective, Oswald (2001, 2006) refocused the security dynamics on individual identity and social representation and on threats, where not only physical survival is in danger, but also the cultural one, often reinforced by religious concerns. Expanding the focus on *gender security*, the author has proposed a "trans-radical" level of expansion where the origins of threats are initially coming from the patriarchal system, characterized by totalitarian institutions such as authoritarian governments, churches, and élites, and then from socially constructed relations. These social relations are present in the most intimate space of a couple and family, affecting labour relations, political and social contacts, and with the exercise of power where a system of discrimination and stigma dominates threatening equity and personal or group identities.

2.3. HUMAN SECURITY

In 1999, the governments of Norway and Canada (Government of Canada, 1999) together with likeminded states have launched the Human Security Network (HSN) that has dealt with agreements against antipersonnel land mines and small arms. In cooperation with scientists and civil society they developed the first pillar of human security or "*freedom from fear*". Confronted with increasing poverty, social insecurity, risks, the Japanese Government has promoted security for human beings and societies, creating a second pillar or "*freedom from want*". In their report "*Security now*", Sadako Ogata and Amartya Sen (2003) – as chairpersons of the Human Security Commission – linked the human security concept to poverty alleviation, a life with dignity, the right for minimal human needs, physical security, fight against organized crime, and respect for life in all forms, including good governance and the fight against state violence, torture, and repression.

In his assessment of the MDGS and his proposals for UN reform, Kofi Annan (2005) asked in his report *In larger freedom: towards development, security* and human rights for all for freedom for a life with dignity for all human beings, respect for human rights, empowerment of poor people, especially the highly vulnerable, such as women, elders, children, invalids, unemployed, and other vulnerable groups. Through the consolidation of institutions, the reinforcement of laws and the improvement of socio-economic conditions for the poorest, reducing the debt services for the most needed countries and social groups he suggested that these structural changes should offer conditions for living in dignity for all human beings, improving non-violent conflict resolution and arbitration by neutral, technically highly trained experts.

Due to the increasing number and severity of disasters (see Figure 1), affecting regions and social groups differently, but producing severe damage to the highly vulnerable, Bogardi and Brauch (2005) developed a fourth pillar of citizen protection they labelled "*freedom from hazard impacts*". The increasing threats to environmental security are related to a cluster of at least six key factors of Brauch's (2003, 2005a) "survival hexagon" representing the three elements of nature or supply factors: soil and water (degradation and scarcity), air (pollution, climate change, ozone layer depletion), as well as three demand factors such as population growth, urban (urbanization, anthropogenic pollution and contamination) and rural factors (agriculture, food production, minerals, fibres and industrial inputs). These anthropogenic, as well as natural variability factors have contributed to global and climate change, soil erosion, food scarcity and alteration of hydrological cycles.

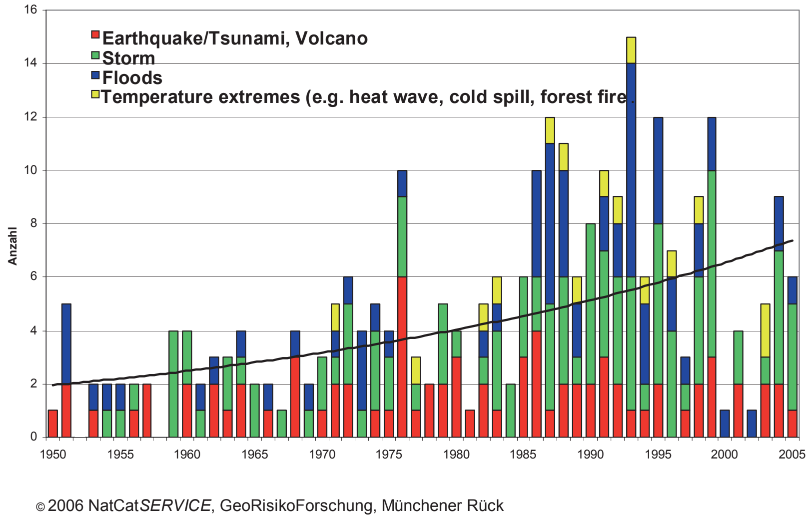

Figure 1. Major Natural Disasters 1950 – 2005: 55 years.

2.4. ENVIRONMENTAL SECURITY

Threats, challenges, vulnerabilities and risks linked to mislabelled "natural disasters" (Figure 1) are related to chaotic urbanization, accidents of industrial toxics, emissions, as well as pollution of air, soil and water, exploitation of natural resources, violence and thus an increasing human insecurity. The complexity of these new circumstances should not only be explained in terms of human security, but also linked to environmental issues.

The concept of environmental security was introduced by Ullman in 1983 and in 1989 Mathews and Myers entered it into the US national security debate. According to Dalby (2002) and Brauch (2003) the concept of *environmental security* progressed in three stages. The scientific discussion was centered in a first phase in analysing the impacts of war on the environment. In this research phase the main concern was to understand the complex relationship of arms, arms racing, armed conflicts and the use, stockpiling and destruction of different types of arms and their impact on the environment in the short, medium and long term. Westing (1986, 1988, 1989) analysed systematically the impacts of wars and armed conflicts on the environment and UNEP has been involved in this topic since 2001 (UNEP, 2004). In phase II, two comprehensive empirical environmental research projects were conducted by the "Toronto Group" (Homer-Dixon, 1999, 2000) and the "Swiss Group" (Bächler, et al., 2002) to explore the relationship between scarcity of resources and violent outcomes. Phase III relies on multidisciplinary comparative and conceptual deepening, using modelling, "on management efforts and focusing on the conflict potential of resource use (Shiva, 2003), on state failure, and on syndromes of global change" (2002, 2005: 20). And phase IV is proposing to link social, political, human, environmental, and cultural aspects with peace-building and Human, Gender and Environmental Security (HUGE) (Dalby et al., 2007; Oswald et al., 2007).

2.5. INTERRELATION BETWEEN HUMAN AND ENVIRONMENTAL SECURITY

The interrelationship between human security and environmental risks inspired several authors to enhance the concept of environmental security. In a first approach, conflicts with violent results were related to shortage of resources (Gleick, 1993, 2001; Biswas, 1999, 2004), linking the increasing deterioration of the environment to technical solutions and political agreements. The *Cornucopians* (CNA, 2004; Gleditsch, 2001; Lomborg, 2002) proposed cheap methods for desalinization of sea water to resolve problems of water shortage, given that 96.5% of the liquid is located in the oceans. They are interested in high technologies; such as the generation of hydrogen from solar energy in the distant future, that would permit gigantic sources of energy almost unlimited as well as in nano and biotechnology, to remedy sewage water at low costs. There was a third group of approaches, the *Neo-Malthusians*, who often linked increasing resource scarcity and conflicts to demand increases due to demographic problems (World Bank, 2004; FAO, 2005).

The second group, the *politicians* (Selby, 2003; Kipping and Lindemann, 2005; Gleick, 2001) are less optimistic and emphasize that it is necessary to take the distribution of water into account, the specific interests of groups and the physical deterioration in international basins, as a result of a growing contamination. These problems cannot be resolved in the institutional framework of sovereign countries and specific policies and negotiations are required, in a field where neighbouring nations can find collective advantages to get a friendly arrangement by consensus (Oswald, 2006).

On the other hand, Schwartz (2002) combined socio-economic factors with environmental stress and violent outcomes; Bohle (2002) elaborated a scheme linking human security with globalization and the Swiss group (Bächler et al.) related human activities to natural factors, economic agents and through networks of pro-active empowerment tried to increase resilience to reduce risks and disasters. Furthermore, anthropological studies and gender-specific research on social vulnerability have confirmed that women, children, and elders show a higher death toll and damage during disasters.

2.6. GENDER SECURITY

Gender security refers to the process of socialization to "become" a gendered human being; a man or a woman, depending on the position of the social structure. As the relationship between man and women shows complex interlinks and is partially related to societal security, the threats are not always perceived as purely confronted[2]. Family structures, schools, work, and clubs are organized to subsume women within daily life, avoiding also that gender get organized as a social group with common interests. Religions in the East and West are strongly reinforcing existing gender differences, but similar to gender divisions religious roles and norms are also socially constructed. Everybody is born with a body which acquires a generic significance in this world (de Beauvoir, 1949). From early childhood gender is socialized (Lloyd and Duveen, 1992; Piaget, 1950) and consolidated during the personal life history. The world was organized for millennia based on gender relations, creating discrimination and invisibility of women (see Table 2).

Gender identity[3] as a socially constructed reality explains how a person is socially identified, or how the society perceives him or her as a man or a woman. Its formation is a complex process of socialization and acquiring social roles. The symbolic distribution of space and time assigns the men the public sphere: production, *res publica*, *homo sapiens*; and to the women the private space: reproduction, home, *homo domesticus.* The distribution of power acquires also generic forms. Men exercise a hierarchical and vertical power of domination and supriority. Thousands of years have developed symbolic elements – class, ethnicity, age, religion, race, nationality, professional adscription, ideology, in permanent change. But the main attributes – gender, sex and race – and the socioeconomic conditions – rich, poor – have been stable (Habermas, 2000). Gender discrimination

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[2]However, the highest rate of violence is within families. UNIFEM (2005) calculates that about one-fifths of women worldwide are raped during their life, mostly within their houses. Around on third of women is beaten but the intra-familiar violence is not yet recognized as a legal problem, because it is normally taken as normal from a male standpoint. Most of the countries in the South still miss any laws against this kind of violence and when it formally exists there is no reinforcement, due to male judges or patriarchal impartation of law and power.

[3]Identity and gender are defined as "a social construct regarding culture-bound conventions, roles and behaviours for, as well as relationships between and among, women and men and boys and girls" (Krieger, N.A. 2001, pp. 693–700).

TABLE 2. Gender equity indicators (United Nations Statistics Division (UNSD), 2005 http://unstats.un.org/unsd/demographic/products/indwm/ww2005/tab4b.htm)

Gender Equity Indicator	Lowest Country	Worldwide Average	Highest Country	Countries Reporting	Year Reported
Ratio of girls to boys in primary education	0.63	0.95	1.03	163	2001
Ratio of girls to boys in secondary education	0.46	0.69	1.39	144	2001
Ratio of girls to boys in tertiary education	0.15	1.13	336	116	2001
Ratio of literate women to literate men	0.42	0.93	1.09	123	2004
Women's share in salaried office employment (%)	6.1	40.26	55.9	136	2003
National parliament seats held by women (%)	0	14.43	49	182	2005
U.N. Gender Equity Index (combined male-female parity in economic, political, and resource decision)	0.123	0.551	0.908	78	2003

is produced by *patriarchy.* It is marked by the supremacy of a male figure subordinating women, children, and those whose gender and bodies defy traditional man/woman categorization.

2.6.1. History of Gender Security

The study of gender security has passed through several phases. The first phase is linked to the theoretical feminism and the demand for female vote and greater equality. It was a response to the evident gaps in gender differences. Friedan (1963), Millet (1969), Mitchel (1972), and social movements with peasants and indigenous groups reinforced feminist requests and linked them to peace research (Boulding, 1991, 2000; Reardon, 1996) and neo-feminism or post-feminism.

The second phase started with ecofeminism where Rich (1986), Mies (1998), and Shiva (1997) discovered the same process of exploitation in nature and women by patriarchy. Resulting from these analyses, women deepened their interest in gender security, and promoted scientific gender sensitivity, where epistemological feminism offered solid bases for a critical feminist empiricism, postmodern feminism and standpoint feminism.

The third phase of gender security consolidated the fight against inequity, where social movements brought in alternative behaviour. The struggle against neo-liberal globalization (Seattle, Social World Fora, economy of solidarity) opened the way for unconventional knowledge located in space and time, and with inside views and different positions. Emotions, attitudes, interests, and values were analysed as a source to explicit values, worldviews and mindsets.

Epistemic relations with other inquirers, situated knowledge, and formal and informal forms of comprehension permitted to inquire authorities and dominant paradigms. As alternatives, explored women's gift economy, others the subsistence perspectives or survival strategies (Bennholdt-Thompsen et al., 1994, 1999), linking scientific theories to practice.

2.6.2. Human, Gender and Environmental Security: HUGE

Oswald (2001, 2004, 2006) suggested an integrated concept of HUGE that combines a widen gender concept including children, elders, indigenous and other vulnerable groups with a human-centred focus on environmental security and peace challenges. The HUGE concept analyses the patriarchal, violent and exclusive structures within the family and society questioning the existing process of social representation-building and traditional role assignation between genders by overcoming the consolidated discrimination of women but also some narrow feminist approaches of the male-female opposition.

It reorients "human security" to create equity and development through social organization, specific governmental policies, private ethical investments and legal reinforcements by stimulating socio-political participation of women, the young and elders. At the international level HUGE improves free and equal access to world and regional markets without trade distortions. It stimulates further world solidarity to support the poorest countries with financial aid, technological support and debt relief.

As a holist concept, HUGE includes "environmental security" concerns where a healthy environment, integral management of natural resources, prevention and remediation practices reduce vulnerability of hazard impacts. Hazard-prone countries are enabled to develop technical, economic, and human support to reduce social vulnerability, to progress in internal organization and to stimulate resilience-building, supporting rapidly and efficiently regions affected by social and natural disasters, counting also on efficient external help. It enables especially vulnerable such as women and exposed groups to reinforce their own resilience-building through bottom-up internal organization combined with top-down policies and institutions capable to guarantee effective early warning, evacuation, disaster support and reconstruction in regions affected by social and natural disasters.

As non-violent conflict resolution is a central part of personal and social identity in a world where processes of unification and diversification are occurring quicker than ever in history, human beings must simplify and to put order into complex realities through social comparisons. These systems of values, ideas, and practices simultaneously create processes of living together, offering persons and groups the possibility to get familiarized with the social and material world, on behalf of contradictory messages and behaviour. Finally HUGE includes the consolidation of participatory democracy and governance, promoting conflict prevention, non-violent conflict resolution processes and peace-building; in summary a "huge" solidarity process of sustainable, human centred and equal development.

2.7. RISKS AND CHALLENGES FROM HAZARD AND DISASTERS

The complexity of water management creates many challenges and 87% of all disasters are water-related. Risks represent a multiplying force between hazards, vulnerabilities, and exposure to physical, natural, social, political, and cultural threats: *Risk = Hazards × Vulnerabilities* sometimes multiplied by the ***E****xposure* to a physical threat (SEGOB/CENAPRED, Mexico, 2005); *H* and *V* are estimated probabilistically; *E* is evaluated in monetary terms. The UNISDR defined it as: "The probability of harmful consequences or expected losses – deaths, injuries, property, livelihoods, economic activities resulting from interaction between natural or human-induced hazards and vulnerable conditions" (ISDR, 2004: 6). However, social contexts can change the perception of risks and their underlying causes as the three hurricanes in the Caribbean during 2005 have shown (Katrina in New Orleans and Stan in Mexico, both were classified as hurricanes of category 3 with high death tolls and Wilma as category 5 with low number of fatalities but high economic losses in Mexico). The challenges for governments and societies consist of a combination of potential and real institutional, societal, economic, and political processes, able to make risk, fear and hazard manageable. Capacity-building is understood as "a combination of all the strengths and resources available within a community, society, or organization that can reduce the level or risk, or the effects of a disaster" (ISDR, 2004: 2).

2.8. SOCIAL VULNERABILITY

However, increasingly studies have argued that disasters occur and are aggravated due to social vulnerability. O'Riordan (2002: 369) relates social vulnerability to "poverty, exclusion, marginalization and inequities in material consumption." ISDR defines it as "the conditions determined by physical, social, economic, and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards" (ISDR, 2004: 7). Oliver-Smith (2004:11) relates it conceptually to the interaction of nature and culture, linked to "social and economic structures, cultural norms and values and environmental hazards." Finally, Wisner (2004: 194–205) argues that vulnerability can increase empowerment of victims, and distinguish four approaches of social vulnerability: demographic, taxonomic, situational, contextual or proactive one (Brauch, 2005b). In summary, social contexts change the perception of risks and hazards, depending on related causes. This shows that a disaster depends basically on social processes as a result of its structure and social interaction.

In dealing with social vulnerabilities, Nathan (2007) separates the process of exposition from capacity-building to counter risks. The physical exposition depends on population density, existing infrastructure, services, and socio-environmental factors which could alter the processes of natural mitigation (destroyed mangroves could not reduce the impact of waves during a tsunami; deforestation in mountains increases landslides; human settlement in river basins are threatened by floods). The same author insists that the incapacity to prevent, prepare, confront and manage hazards could be separated into physical weakness, legal, organizational, technical, political, socio-economic, psychological and cultural vulnerability. Birkman (2005) maintains that a system of early warning and management of risks has to be applied in prospective and corrective ways, confronting better threats and reducing risks, human and material losses, and socio-environmental disasters. Villagran (2007) insisted that "early warning systems and other measures associated to disaster preparedness are examples which lay the foundation" for a bottom-up and top-down approach within developing nations to reduce natural disasters and to find "ways to minimize their impact combining efforts of government agencies, the private sector, and civil society".

Cardona (2004) related the growth of social vulnerability to a weak or non-existent development or to the lack of a culture of prevention, especially in the Third World, such as chaotic urbanization, industrialization, lack of internalization of environmental externalities, dangerous infrastructure, and corrupt administrations, which have increased risks and vulnerabilities. Furthermore, false policies could trigger human inducements of disasters, such as famine, which are generally of longer duration and with major human losses.

Vulnerability assessment requires collecting and analysing data linked to building consciousness and institutions on:

- Types of hazards and frequency
- Elements at risk and how to reduce them
- Socio-economic conditions and types of shelter
- Gender and family structure
- Genuine coping strategies
- Mapping specific hazard prone locations
- Learning from previous disasters and coping strategies
- Training for evacuation
- Resettlement of people at risk
- Evaluation of training and hazard mitigation process

2.9. RESILIENCE-BUILDING BOTTOM-UP

Resilience means in Latin *resiliens* and *entis*, referring to "return from a leap, jump, rebound", and generally "elasticity". In physics it represents the capacity of a material to recover the same form after having been exposed to extreme pressures. In the social field it refers to the "human capacity which permits persons after having passed through adverse situations to be not only safe but also transformed through this experience" (Chamochumbi, 2004). Gloria Laengle (2004: 1) defines it as "the capacity of human beings to overcome difficulties and at the same time learning from the errors" and Ángela Quintero (2001: 1) as "the capacity of a family to adapt and reconstruct from the adverse situation." Helena Combariza (2004: 1) characterizes "human resilience as the capacity of an individual or social system to live well and develop positively, irrespective of the difficult conditions and even being reinforced and transformed" (Arias, 2004:12; Quintero Velazquez, 2004).

Officially resilience is understood as the "the capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure. This is determined by the degree to which the social system is capable of organizing itself to increase its capacity for learning from past disasters for better futures, protection and to improve risk reduction measures." (ISDR, 2004: 6)

In dealing with emergencies it is important to increase resilience, understood as "the capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure. This is determined by the degree to which the social system is capable of organizing itself to increase its capacity for learning from the past disasters for better futures protection and to improve risk reduction measures." (ISDR, 2004: 6)

Table 3 synthesises the impacts of hazards and risks that may lead to natural hazards and human disasters in the world. It distinguishes between threats, official answers, and the capacity of resilience of the affected and most relevant outcomes. Linking social vulnerability with global changes, hazards, and risks, particularly densely populated mega cities and rural areas in the South will correspond to higher fragility.

3. Risks, Social Vulnerabilities and Hazards in Mexico

Like the Middle East, Mexico is a hazard prone region exposed to multiple natural, social, political and cultural risks. The socio-environmental situation is aggravated by global warming (Grassl, 2006) and social inequality (Strahm and Oswald, 1990; Oswald, 1999). On global environmental change Steffens et al.

(2004) conclude that "the relationship between humans and the environment has changed irreparably in a few centuries, particularly during the last 50 years". The effects of climate change on hydrological cycles and the resources destined for human use are becoming increasingly unpredictable. In tropical areas, rainfall declined by 3% and "in the northern hemisphere precipitations have increased during the past century" (2004: 196). These data coincide with the Intergovernmental Panel on Climate Change (IPCC), which reports a reduction in the recuperation of aquifers due to a minor flow of surface water. The disposal of water and hydro-stress will increase in semiarid and arid ecosystems. Secondly, natural disasters will intensify – especially drought and flash floods. Thirdly, the quality of water will deteriorate, due to climate change, further reducing water disposal in zones with existing water stress, due to high population growth rates, agricultural (ab)use as well as urbanization and industrialization.

TABLE 3. Impacts of hazards, risks and disasters (WWAP, modified by Oswald, 2005)

Natural	Productive	Social	Industrial	International
Human loss Destruction of infrastructure public and private Chemical Pollution Refugees Immigrants International help Environmental cleaning Famines Survival dilemma	Economic crisis Social Inequality Pollution of inputs Food scarcity Reduction of goods for massive consumption Poverty Unemployment Deterioration of productive infrastructure	Bad functioning of institution Administrative collapse Political Instability Internal conflicts Strikes Migration Loss of acquisitive power Discrimination of gender Marginalization Internal refugees Chaotic Urbanization	Chemical Contamination Industrial accidents Collapse of productive system Work accidents Labor illnesses Conflictive climate of work Abandoned housing zones	Miss of cooperation Collapse of regional environmental collaboration Concentration of natural resources Political and institutional conflicts Epidemics Reduction of support to science and technology Migration Brain drain civil wars External refugees

Less water and greater contamination are the challenges of the future, where a rational management of resources – savings, reuse and reduction of water pollution – along with environmental education, offer alternatives from home to public and industry (Oswald, 2003). According to the reports of the Mexican Government for climate change (Mexico, 1997; Brauch, 1998; IPCC, 2000, 2001, 2004), the country is exposed to multiple risks and hazards that could soon become disasters (see Table 4).

According to official data, climate change can generate greater droughts affecting between 58–65% of the productive area of corn, with a possibility of final loss (Reports of Mexico to UNFCCC, 1997, 2001, and 2004). The rising sea-level due to the melting of the ice in the Arctic and Antarctic and the temperature increase raise the probability of cyclones with higher intensity (scale Saffir-Simpson from 4 to 5). Due to sea level rise, the coasts will erode and highly productive areas may be lost by intruding salty water. In addition, aquifers tend to increase salinity due to changes in the equilibrium of the hydro-electric flows and the intrusion of salty water from the sea. Likewise, it is estimated that the temperature variation may become more extreme (heat waves and extreme cold events). Furthermore, this complex interplay may also threaten large parts of Mexico's territory by desertification, changing the productive opportunities and inducing migration (see Figure 2) in the centre of the country with high population density and a semiarid climate.

TABLE 4. Natural risks in Mexico: volcanoes, earthquakes, floods, hurricanes, landslides (Mexico, Ministry of Interior, 2004)

Average risk	Persons affected (millions)	% of population affected
Very high	28.6	26
High	11.0	10
Regular	24.2	22
Low	14.3	13
Very Low	31.9	29

During the last 20 years the consumption of water in Mexico has doubled, producing water stress in time (dry season) and space (semi-arid and arid regions). This phenomenon increases when processes such as global warming, changes in demographic trends, migration, changes in food habits and hygiene are taken into account.

The water supply differs regionally and in time: the Southeast receives 78% of rainfall, but has only 23% of the population; it generates 16% of the GDP and has only 8% of the irrigated land (CNA, 2004). Around 80% of the Mexican territory is semi-arid and arid, and 70% of its population lives in this area and produces 84% of the GDP, but this region supplies only 28% of the water for industry, population, and agriculture[4] (CNA, 2005). About 39% of Mexicans

[4]This national account does not include the environmental services such as hydro-energy, bio-mass, CO_2 mitigation, oil from land platforms, and other natural resources such as biodiversity, air, and water.

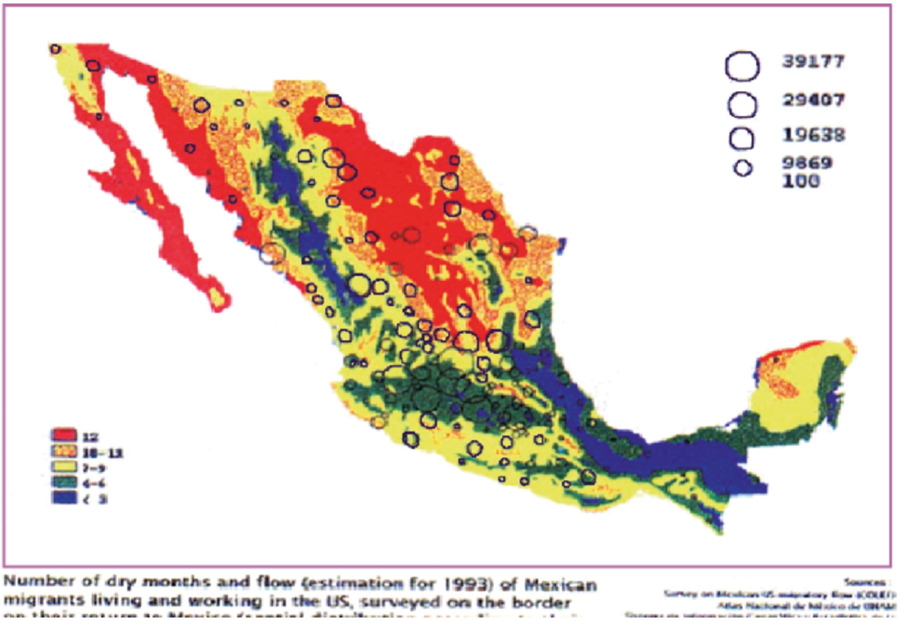

Figure 2. Number of dry days and migration.

have no access to water in their houses or land, and almost nobody has safe water, what has been generating water-borne illnesses affecting life quality. Together with other regional stressors, such as chaotic urbanization and pollution they are hindering the socio-economic development of important regions. Furthermore, natural disasters affecting big cities are getting more frequent, bringing also secondary effects such as pollution by industrial hazardous products stationed in these cities or the destruction of basic infrastructure (water pipes, sewage facilities, gas lines).

Decades of mismanagement of rural policy have destroyed often the precarious survival possibilities of peasants and indigenous people. Alongside droughts, floods, new plagues and loss of natural fertility of soils are affecting their livelihood. Water scarcity often creates conflicts among different types of users, especially in the semi-arid zones, where 92% of irrigation systems are located. Agriculture still uses between 78% and 82% of water during the last decade and generates between 5% to 7% of the GDP of the primary sector. Especially conflictive has been the water access in the region of the superior Balsas and Lerma, located in the most populated region of the country, where migration and population growth is linking secondary cities such as Puebla, Tlaxcala, Pachuca, Querétaro, Toluca, and Cuernavaca to Mexico City, creating an urbanized region of 35 million inhabitants.

In areas of extreme poverty, rates of fertility are still above national average. In Mexico, social inequality (Table 5) creates high social vulnerability and impedes to progress towards greater resilience, obliging the marginalized to migrate. Furthermore, these poor migrants could not find a safe place to build their houses, because urban speculators have taken the secure land for their urban development. They are obliged to settle in hazardous areas, where landslides, floods, and industrial pollution create dangers for their life and increase existing social vulnerability (Wisner, 2004; Bohle, 2002). Beside these risks, human-induced threats created by hunger, undernourishment and obesity threaten the health of this poor population. In addition, public insecurity created by local drug dealers, youth gangs and corrupt police often oblige this marginalized to abandon the little they have, just to save their life.

TABLE 5. Social vulnerability as internal inequity within Mexico (INEGI, 2004 and Banco de México, 2004)

Concept	% or population	% of national wealth	% of financial savings
Rich	0.23	40.3	78.0
Poor	52.7	18.4	10.0

Three decades of socio-economic crises have aggravated the rural-urban migration, creating huge shanty towns in big cities inducing a chaotic urbanization with limited quality of life. Missing services of water, drainage, electricity, polluted air, and precarious shelters are affecting the health of these marginalized people. The combined economic and social crises are further aggravated by environmental insecurity and lacking job opportunities. The causes of social stress are also linked to the worsening of the complex socio-environmental context. If the state, the economy and the society fail in finding solutions for this growing deterioration, the associated political risks may increase and become unmanageable due to more frequent and stronger disasters and water stress (see Figure 1). Without prevention, mitigation, and resilience, local conflicts may involve more extensive regions and the crisis may trigger violent confrontations.

As empirical studies have shown among the most vulnerable in situations of emergency are women, children, natives, and the elderly who are threatened by environmental risks. This may escalate to urban violence and confrontation over land and access to water in rural areas that could provoke confrontations among communities, regions and countries. The maps of nutritional emergency of the FAO show that nations with famine are also affected by wars, revolts and failed governments (see Haiti and Sudan). These confrontations could create domestic instability and violence provoking wider internal conflicts. Growth in population, declining food supply, deterioration in social conditions and incremental or abrupt climate change may aggravate this spiral of violence and create specific conditions of shortage and deterioration of water that can often only be overcome by migration into regions of greater availability of water, land, and jobs, in order to escape the "survival dilemma" (Brauch, 2005a) that offers for the affected people only few alternatives:

1. To migrate massively to shanty-towns in the outskirts of large cities
2. To emigrate illegally to the USA
3. To send a part of the family to the USA and to rely for a living at home on the remittances by family members
4. To expect that the government resolves the problems exercising pressure through popular organization and demonstrations, but suffering the deterioration at the expense of their life quality
5. To reduce the consumption and aspirations for an amelioration, due to a lack of water and food, air and soil pollution, often aggravated by epidemics and chronic illnesses
6. To steal from the neighbour the few he has or to get involved in illegal activities and organized crime
7. To organize bottom-up within an economic framework of solidarity, where micro-enterprises are linked with business incubators and popular banks which collectively struggle to improve the socio-economic situation and employment (Cadena, 2003, 2005; Saviñón, 2003, Lopezllera, 2003)

Combining these activities with environmental services and a sustainable management of the environment, gradually the adverse conditions could be mitigated consolidating the behaviour of resilience within these communities. There is no doubt that several of these options can be combined and people exposed to critical survival conditions will try to optimize their alternative strategies to guarantee at least the survival of a part of their family.

Migration to the USA has not only enlarged bilateral disputes, but has also created tensions within the peasant communities at home and above. When immigration increases, the struggle for employment, water, land, shelter, and food could become more severe and violence could spread. Besides processes of discrimination, also xenophobia and physical aggression become more frequent (see the activity of some hunting clubs in Arizona against Mexican immigrants). Furthermore, in the border region, the management of the River Bravo – one of the basins threatened by drought like the Jordan valley – the local political situation and the social vulnerability of the poor population may become more explosive and could deteriorate the relationship between both countries and armed violence could start.

All these phenomena related to the most vulnerable with regard to social class, gender and age are to be analysed in the framework of the HUGE concept. When the disputes on indispensable resources such as water is aggravated by massive immigration, climate change and the impacts of exclusive globalization, latent conflict tendencies may lead to major political conflict between both nations. When the offer of water is reduced while the demand grows, only political agreements can avoid violent disputes among social groups, regions, and countries. However, any such conflictive escalation would affect even more the precarious conditions of the marginalized population facing water stress. Confronted with difficult natural conditions, it is urgent to develop mechanisms of non-violent conflict resolution to protect natives, the lower income and social classes, as well as women, elders, and young people, or in synthesis, vulnerable groups.

4. Hydro-diplomacy or Conflicts: Case of Mexico and the USA

Given the potential for conflicts on water access and distribution between the USA and Mexico along its more than 3,000 km of joint border and shared river basins and aquifers, an integrative *hydro-diplomacy* (see Figure 3) is proposed. Hydro-diplomacy plans to reduce water demand and to widen its supply simultaneously. It proposes cooperative relations for an integrated basin management within an arid ecosystem taking other natural resources between both neighbours into account (Achiron-Frumkin and Frumkin, 2006). To adapt the existing demand to its supply (Oswald, 2005) aquifers (Loehman, 2006) and surface-basin management (Gat, 2006), changes of land and water uses (e.g. virtual water, Allan, 2003; Shuval, 2006), rainwater harvesting, recollection of sewage, and reuse of treated water can reinforce the proposal.

Neighbouring governments and social groups should negotiate an economic management of this scarce resource (Fisher, 2006). Both, resource-management (Al-Saad, 2006) activities and concerns about HUGE could also be reinforced by scientific and technological training to optimize the existing financial and physical resources (Dombrowsky, 2003). In addition, the organization of all sectors of society with a bottom-up approach could promote a new culture of water (Oswald, 1999).

Through non-violent negotiations of water disputes, achieving a consensus among antagonistic groups, economic concerns, and a separation from wider geopolitical and military interests (Fisher, 2006) improve the possibility of a win-win situation. Technical solutions (desalinization of brackish and sea water), infrastructure for sewage recollection, treatment plants, and recycling facilities could increase the availability and quality of the vital liquid also for complex and fragile ecosystems and future developments.

Diverse legal disputes have risen among the interpretation and fulfilment of the international bilateral treaty signed in 1944 for the shared Rio Grande or Rio Bravo between Mexico and the USA. Due to desertification and drought for a decade the river is not reaching the sea during the dry season, because of multiple upstream uses of agriculture, service, and industries. Furthermore, the quality of water is severely deteriorated through manifold contamination, above all by the agricultural sector. Municipalities, states, and national governments mutually blame each other for not caring about the health of the river.

The resolution of disputes through hydro-diplomatic activities (Figure 3) could reduce the threats for Mexico's poor urban population and their activities resulting from the violations of the treaty by American farmers that have also seriously affected the desert of Chihuahua (with a high biodiversity). Powerful farmers from Texas, Colorado, and New Mexico living upstream have deliberately retained water to satisfy their economic interests, and thus the water reaching Mexico has already been contaminated. This could transform the border zone from a highly conflictive into a violent area, especially due to population growth on the Mexican side, partly due to migration and a stagnant economic development. This has also limited the expansion of the *maquila* enterprises which exploit cheap labour costs south of the border.

The Rio Grande Basin supplies water to Colorado, New Mexico, Texas in the USA, and on the Mexican side to eleven municipalities, five states, and to the desert of Chihuahua before it flows into the Gulf of Mexico. It is 1,900 miles long, the fifth largest river in North America, and originates in Colorado. It crosses the driest region in both countries. During the past decades, 10 million newcomers have settled along the border and river basin but no state or country has taken care of an integral-basin management. Diverse interests have competed for the primary use of water. Currently, more than 80% of the water serves for irrigation, and multiple deviations have been established. The restoration of the Rio Grande is crucial, since it is the only river in the USA that is threatened to dry out during the next decades. Multiple efforts have been undertaken to recuperate the swamps and the dried out marshes. The restoration of the natural equilibrium could increase the residual humidity, restore ecosystems, and sustain productive processes. All these efforts are beneficial for both sides, but especially for Mexico, where severe contamination exists from agrochemicals, human settlements, and industries.

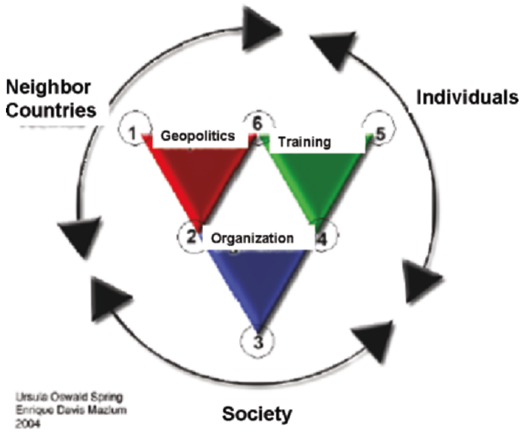

Figure 3. Conflict Resolution through Hydro-Diplomacy.

Furthermore, the aquifers are overexploited and a severe ban of new drilling has been declared. However, illegal drilling is taken place. There may also be fewer recharges of aquifers due to the complex process of climate change. The loss of natural vegetation by anthropogenic practices, such as the expansion of urban-industrial areas, population growth, deforestation, and farming are reducing evaporation from soil, affecting the formation of clouds and precipitation, inducing growing conditions of aridity. The conjunction of these phenomena reduces both the recharge of the joint aquifer, and the availability of surface water. Greater population and bigger demands from industry and agriculture can induce citizens to violent actions to appropriate the vital liquid. This crisis situation could oblige the authorities of both countries to intervene and one of the extreme outcomes can be a violent conflict over the use of this scarce resource, destroying further the fragile region.

How could this river be shared in a peaceful and sustainable way confronted with a growing demand, contamination, and climate change leading to severe water shortages affecting both sides? What can Mexico do as a developing and threshold country located downstream without political or military strength to get its traditional and natural water rights respected that date back prior to the agreement of 1944 with its powerful neighbour? A similar situation applies to the indigenous population living in reserves and the historical owners of this natural good. The history of the water sharing of both countries has been complex and always full of tensions.

Big dams and other hydraulic projects affected severely the habitat and the aquatic species. In 1992, a group of US environmentalists succeeded that the

Grand Canyon was protected, requesting from the users of the lower basin the obligation to take care about their own ecosystem. Due to the intervention of these ecologists and the determination of the US Supreme Court, there is hope for a major change in the hydro-politics of the USA. But this example also illustrates further contradictions: first an ecosystem and specifically a fish is protected before the poorer Mexicans are supplied with water. It showed also the complexity of the management of the river. The farmers of Texas, despite their unwillingness to sacrifice their cultivated land and risking their profits, must now execute the judicial decision and restore the equilibrium in the lower river basin. It may be expected that this process of environmental care will improve the disposal of water for human supply, especially on the Mexican side where drinking water is lacking. In the medium term, this could require a renegotiation of the agricultural quotas for irrigation in Texas.

But there are not only conflicts on the northern border. Since the 1980s the collaboration among both countries has been consolidated. In 1983, the Agreement of Cooperation for Protection and Improvement of Environment in the Border Area was signed resolving the sewage discharged into the river and the bay of San Diego. In the framework of the North American Free Trade Agreement (NAFTA), an Ecological Commission on Border Cooperation was set up and the North American Development Bank (NADBank)is financing environmental projects. Both agencies have tried to strengthen citizens' participation, controlling corruption, and improving the technical capacity in Mexican municipalities.

Both collaboration and hydro-diplomacy can reduce the irrational exploitation of aquifers by improving irrigation (micro-aspersion, drop-irrigation, channels, water saving, change in cultivations cycle and crops), saving about 40% of the water. Furthermore, changes in the water use from golf courses to agriculture, recycling treated water in agriculture and industry, reducing subsidies for industry and farms, and raising tariffs covering full costs of sanitation, maintenance, and the creation of hydro-infrastructure opens a *market for integral water management* and environmental services. In the *environmental field* it is necessary to promote a new culture of water, the sustainable management of solid waste and a recuperation of destroyed ecosystems, threatened by desertification, inducing massive reforestation with native plants. Some ecosystems are unique in the world and somehow a patrimony for humanity. Finally, water-extraction policies of aquifers have led to an overexploitation and salinization (Oswald, 1984).

The geo-political approach includes long-term plans to deal with greater water shortage and vulnerability. Climate change and population density in urban zones have altered rainfall patterns. Both may generate more extreme climatic conditions. Given this challenge, it is urgent to establish and reinforce norms and laws to protect the existing natural systems, channelling demographic growth into zones with low environmental impact, reorient water projects toward sustainability on both sides of the border, and avoid any destruction of native forests and vegetation.

The higher complexity affects also *social aspects*, where opposed interests require a resolution of conflicts by training each citizen and organized social groups in alternative water management. The Native Americans in their reservations, the original owners of these resources are demanding a sustainable management of the river without dams, a recuperation of their land, and the protection of their native flora, fauna, and natural ecosystems.

In the field of *science and technology* creative inhabitants could reinforce the environmental management of the region. Undoubtedly conflicts exist and may escalate, but social organization is able to control corruption and promote honest public administration, environmental management reflecting arid conditions, indigenous advice, and active participation of citizens with reinforced laws and norms could contain or slow down the impacts of climate change. Such strategies include also the reduction of disparity between countries, between over and less developed zones and different social classes, where progressive taxes and private and social solidarity supported by joint policies could control individual, short-term interests, many of them have been unsustainable.

Figure 3 systematizes levels of interaction and links actors – e.g. the government and its agencies – with processes. Since both nations have agreed to reinforce a peaceful and sustainable development, a common policy may reduce the pressure for migration and avoid future environmentally induced migrants. The model of a systemic interaction permits to build up a complex interaction where sovereignty among nation-states is involved (Kaplan, 2003), and where inequality between Mexico and the USA in cultural, political, economic, military, and organizational terms offers only advantages for Mexico in the environmental field. Nevertheless, both nations have to live peacefully with each other and for this very reason treaties and agreements were and could be negotiated to give the weaker an opportunity to reduce existing inequalities as in the European Union (EU).

To balance the power discrepancy, Mexico could offer an integral system of environmental services lacking in the USA. This would be beneficial for the US region and could stabilize the joint frontier. As multiple phenomena are of a global nature, integral changes in rural policies of Mexico starting with food sovereignty and sustainable management of its natural resources, support environmental services, industrial and service development without pollution, an economy of solidarity could offer employment and welfare in the native country, thus reducing migration pressures from Mexico to shanty towns, both in the northern states of Mexico and in the USA.

Promoting social organization, Mexico could benefit from its long tradition in the practice of solidarity (Lopezllera, 2003), where existing networks of extensive families, *compadrazgos* (godfathers and godmothers), villages, urban colonies, and economic organization could be widened. Linking productive organization, commercialization, and consumption with training (*point 4*), able to build up integrated chains of small businesses and highly specialized productive processes an economy of solidarity could be created (Cadena, 2003, 2005). These activities would permit to reduce the precarious informal economies generating employment, services, and an increasing quality of commodities and life conditions not only in the border region, but due to the remittances also in marginal regions.

Mass media, workshops, and daily practice could support these economic, organizational, and training processes, including the creation of a collective environmental culture for integral management of natural resources. Existing tensions among highly specialized technicians and democratically elected representatives (*point 6*) could be reduced by an academic career required for public officers. This allows a professional handling of the hydrological resources, with long-term plans and qualified specialists responding to the demands of society and the elected authorities, which change periodically due to elections.

Links between geopolitics and social organization (*point 2*) could be conflictive and unpredictable, without a bottom-up strategy involving the society able to develop strategies for different social and professional groups. Training of diplomats in hydro-diplomacy is urgent for both countries and the entire world. They should be able to negotiate non-violent solutions between foreign governments. Another task is reducing contradictions in geopolitical and social terms, deepening the collaboration among the three levels of government, including the population in planning, execution, and maintenance of public works, according to existing territorial, environmental, economic, and associated cultural conditions.

An independent technical agency could handle with systemic competence alternatives for creating the needed infrastructure. The investments could be paid through service quotas and environmental services. This could reduce the initial investment, guarantee the costs of maintenance, and ameliorate the environment. An integral management for the whole river basin and its micro-basins could also facilitate the control, transparency and efficiency of budgets, guaranteeing foreign investments and satisfying the requirements for sustainable development. This independent technical agency could also handle projects in the framework of the Clean Development Mechanism (CDM) within NAFTA and the Kyoto Protocol (UNFCCC, 1998), to which Mexico and Canada but not the USA have become parties.

5. Some Comparative Conclusions for the Middle East

Israel, Jordan, Syria, and Palestine use 95% of their water resources and during drought periods aquifers are overexploited. Due to this severe water scarcity together with pollution different parallels can be found between the Middle East and the Mexican-US border. Their environmental-transboundary problems affect both domestic and foreign policies, in addition to its links with demographic change, urbanization, nationalism, security, economic development, culture, and ideology, requiring a multi-actor policy and environment management to avoid conflicts. Wolf (1998) postulated that during the last century 145 water-related treaties have been signed worldwide and only seven skirmishes over water have occurred.

Nevertheless, Ariel Sharon as Defence Minister of Israel argued that the Seven Day War, normally fixed on the 5th of June 1967, started 2.5 years earlier when Israel decided to reverse the Jordan deviation. The broader incentive for the invasion of Lebanon[5] in 1982 was to secure the water of the Litani River. Given the present structure of water policy and economic development together with an average increase of Israel's water consumption by 1%/year these 250–500 million m^3 of additional water supplies can be conceived for Israel only as a short-term solution.

Systematizing some common and some differences between the North American region and the Middle East, the following reflections are proposed:

- In the Middle East, many Arab countries – but not Palestine, Jordan, and Lebanon – have plenty of oil but a high water scarcity. In North America, both the USA and Mexico have oil reserves, however, the weaker Mexico is exporting oil to the powerful USA and both suffer in their border region from severe water scarcity.
- Environmental conditions are similar in both regions. Fragile arid ecosystems experienced during the last 60 years intense migration, industrial development, extensive irrigation projects for agriculture with an intensive use of agrochemicals that polluted both the water and the soils. As a result crop yields declined due to salinization of soils and aquifers, an overexploitation of groundwater and long-lasting droughts.
- There exists a powerful upstream partner: Israel on the occupied Golan Heights controls the water management of the Jordan–Yarmouk River for

[5]During the recent Lebanon war (2006) beside the destruction of infrastructure with an elevated toll of injured and deaths also the fragile environment was damaged. The bombing of the thermoelectric Dschije, destroyed two tanks of fuel polluting in the Mediterranean with a 150 km large and 30–40 km wide nap of oil and a cost for remediation of 30–40 million euros with longer-term impacts for the environment (see for sources the chapter by Brauch in this volume).

four nations, using economic, political, military, societal, and technological advantages. The West Bank has direct access to the abundant Mountain Aquifer, and due to its military authority in the region Israel is using about 25% of its water from this source. Meanwhile the Palestinian Water Authority (PWA) controls the administration of local water supply; drilling and larger new public work requires the approval by Israel's water authorities (Dombrowsky, 2003; Husseini, 2006). From 1991 on, some 55% of Israel's total water supplies came from non-Israeli sources.

- There are vulnerable downstream communities with unequal access to water. After 1991, Israel has increased its control of the Mountain Aquifer and introduced in the West Bank an efficient water use furnishing them an allocation of 4.5% and Israel 95.5%. The use per capita is in Israel 360; Jordan 220, and Palestine 110 m^3/year (Dombrowsky, 2003). There exists also modest infrastructure development in Palestine, and towns and villages suffer from unreliable and insufficient water supplies; some villages are not connected to the water supply pipe system (Gat, 2006). If Palestine exists it would control a quarter of Israel's fresh water and in the south of the Jordan River. This is one of the reasons why Israel has proposed "soft borders" with economic association instead of a sovereign country.
- Israel's "agriculture became more dependent upon irrigation such that demands for water likewise steadily increased. Irrigation in Israel's crop-producing region increased from 15 per cent in 1950 to about 64.2 by the late 1980s. During this period, the average water use/unit area fell by one-third with the introduction of more efficient water-application techniques, such as drip systems. Nevertheless, water demand steadily rose as more immigrants arrived, more land was cultivated and the population of the country grew" (Mostafa Dolatyar, 1995: 4). There is also the collective dream to "bloom the desert".
- Water scarcity constrains agriculture and the Jordan River, thus the lower riparian partner with less rainfall and many disadvantages in its hydrostrategic position, is considering a shift from agriculture to more profitable activities. Jordan is exploring possibilities of water supply form the Daisy Aquifer to Amman. However, on this joint aquifer with Saudi Arabia precise assessments on the quantity and recharge possibilities are lacking. In the rest of the Middle East a shift in water use is contemplated, bringing more "virtual water" in through importing agricultural commodities. For Jordanians probably the desalinization of brackish water from existing aquifers, water harvesting, and recycling of sewage treated water (Tamini, 2006) is the cheapest and sustainable alternative for their

country (see chapter by Samer Talozi in this volume). This requires improving the local culture of water, including demand-side management, promoting water harvesting, saving, recycling, reduction, and reuse of water in any household. These alternatives do not increase the dependency on the neighbours. However, wider agreements on the Jordan River and the Dead Sea are needed, reducing, e.g. the extraction for industrial use. This could mitigate existing water scarcity and the sinking of the sea level of the Dead Sea of 1 m/year with severe environmental implications such as sinking holes affecting tourism, infrastructure and military facilities.

- Governmental and urban planners made in the whole region severe mistakes, forgetting in their projects often the arid environment and the severe natural constraints. Excess of energy and water are consequences impeding a prompt development of a culture of water and sustainable energy.
- Technological alternatives form part of a "cornucopian" mind set (Gleditsch, 2003). The proposed Med-Dead Sea and the Red-Dead Sea Water projects will be expensive. They would cut across through Israel or Jordan. However, besides a feasibility study funded by the World Bank these proposals lack any concrete financial support. The cost of supplying some 700 million m^3/year, through desalinization ranges between \$1.2 billion and \$1.8 billion dollars per year, an amount which neither Israel nor Jordan can afford. Other projects to meet long-term water requirements are to transport a proportion of the water from major rivers of the Middle East, e.g. of the Nile, the Euphrates or Seyhan and Ceyhan Rivers in Turkey to Israel, Jordan and Palestine. No Arab country agreed with this proposal. The project of transporting water from the Antalya region by ship to Israel has been shelved in 2006 for cost reasons.
- The pressure to satisfy the water supply could either foster cooperation or lead to conflicts in this region that has been highly volatile for military confrontations. Shimon Peres declared that "the water shortage proves the objective necessity of establishing a regional system". Otherwise, he cautioned, "the Yarmouk basin may again become the source of dangerous hostility. Yet, he rightly confirmed that like all wars in the political and strategic reality of our times, wars fought over water do not solve anything. Gunfire will not drill wells to irrigate the thirsty land, and after the dust of war has settled, the original problems remain. No war can change geographical givens." While it is true that the water shortage is worsening, the emphasis on cooperation for the establishment of a regional water policy is linked to the fact that Israel depends for 55% of its water demand on foreign water supply.

- Disasters are increasing due to global and climate change. The effects threaten countries, social classes and gender differently. The most vulnerable are Palestinian women and children in refugee camps in Jordan, in the West Bank, and Gaza. Confronted with higher water scarcity due to demand increase aggravated by climate change, complex social networks sustain humans in normal times. Human vulnerabilities during periods of change, hazards, disasters, or conflicts related to global warming and water scarcity, are usually a matter of disruption or failure of these networks. Especially in the Middle East, gender analysis could lead to a more nuanced understanding of women as social beings aligning in networks of family and community. A more accurate understanding and training could facilitate to support networks that underlie a resilient society, where women educate, care, produce, but reproduce also the historical memory and the cultural background. They increasingly generate also the material needs for the family and are able to develop and sustain a water culture and a healthy life. Active female participation in a cultural context of severe female discrimination could open possibilities to reduce gender-related social vulnerabilities, improve water culture and create hazard resilience, able to improve the survival of whole communities frequently affected by water scarcity and hazards. But it could also reduce violence and insecurity before, during and after disasters and severe water constraints, especially affecting women and children who are the first victims of water scarcity and armed conflicts. Finally, the World Bank found that in Arab countries with gender politics GDP increase/year is 1% higher than in neighbouring countries ignoring it.
- An Israeli Defence Minister has promoted "soft borders" as "the only way to equitably solve the problem of distributing water, and the most efficient way to develop agriculture and industry that can compete successfully in world markets". There is no doubt that such a development requires more water. Economic cooperation between Israelis and Palestinians was proposed in the Joint Declaration of Principles, signed on September 13, 1993. However, it implies sharing and Palestine is in a vulnerable situation with less access to water and cannot accept a worsening situation. Arnon Soffer, a water advisor at the Foreign Ministry recommended that Israeli policy-makers begin "to allocate water according to economic rather than political priorities" (Dolatyar, 1995: 7).
- The mentioned projects for the future imply a tension between two possible options: to accept the environmental realities and shift from a cornucopian dream of plenty to a reality of limits and promote within a new culture of water a sustainable development, or to continue with the dream of "blooming

the desert". This option implies technological alternatives and the development of mega-projects, which costs billions of dollars require highly trained specialists that are often lacking in Jordan, Palestine and Syria. Desalinization is contemplated as one of the most feasible option (Brauch, 2006). However, the energy supply is not yet resolved and nuclear and solar are the possible choices having very different environmental impacts. There is a proposal that "Arab oil-producing countries should donate one per cent of their revenues towards regional development that would stretch from Eritrea and Yemen, through the Persian Gulf to Egypt, Lebanon, Jordan, Syria and, of course, Israel. New trans-national railways and roads would be built, water piped, canals constructed, oil distributed, and at the final stage *the desert would turn from brown to green*" (Dolatyar, 1995: 6) within a framework of the associated type of NAFTA. These procedures will accentuate the gap between Israel and the Arab countries, as it has happened between the USA and Mexico.

In conclusion, a hydro-diplomatic approach with gender, human, and environmental sensitivity may facilitate an integral development process that could contribute to improve the quality of life for the people of Jordan, Israel, Palestine, as well as Syria and Lebanon, encourage and consolidate cultural interchanges between the countries, ameliorate or at least maintain the existing environmental conditions, mitigate the effects of global and climate change and support a long-term strategy for life in a complex and fragile ecosystem with ethics (Aureli and Brevet, 2004). Threats for destruction, risks, and disasters could be mitigated, through a systemic cooperation at all levels of governments, social classes, cultures, and races improving resilience of the most vulnerable. This would imply from the Israeli side to reduce the protagonist role living with less military power generating less threats and fear.

What may sound as a "HUGE" utopia of a sustainable and peaceful Human, Gender and Environmental Security, could well gradually become a reality if the political will is created to start with the first modest steps suggested in this chapter.

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PERSPECTIVES ON ALTERNATIVE WATER SOURCES IN EUROPE AND THE MIDDLE EAST

PAUL JEFFREY*
School of Water Sciences, Cranfield University, Cranfield, Bedfordshire MK43 0AL UK

Abstract: Fresh water is no longer taken for granted as a plentiful and always available resource. In addition to drought impacts, the overexploitation of water resources, especially for agriculture, increases the risk of water deficit and, consequently, environmental hazards. The problem of water deficit is further exacerbated by global warming, which is likely to make precipitation patterns more variable, changing the patterns of water availability on a quantitative, temporal, and/or regional basis. Alternative approaches to enhancing resource availability include water recycling, rainwater harvesting, and desalination. This paper explores the drivers for alternative resource development and discusses technology and scheme design choices. Its major emphasis, however, is on the implementation of schemes in terms of their social and economic considerations, as well as their role in Integrated Water Resources Management strategies.

Keywords: alternative water sources; reuse, rainwater; desalination

1. Introduction

The relationship between sustainability and water management is a complex one. On a global scale, there are abundant water resources for human needs. In general terms, the issue is really one of developing water management regimes, which enable us to match local water supply and demand in terms of both quality and quantity. Although many of the challenges to sustainable water supply are global in context (e.g. climate change, population growth, migration, pollution, etc.), their specific impact will be shaped by local environmental,

*To whom correspondence should be addressed. Paul Jeffrey, School of Water Sciences, Cranfield University, Cranfield. Beds. MK43 0AL. UK; E-mail: P.J.Jeffrey@cranfield.ac.uk

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economic, and cultural circumstances. The problem can also be stated in terms of balancing competing local demands on water as a natural resource and as a commodity for human consumption (Langford, 2005).

Whilst there remain many opportunities for improving the efficiency of water use and promoting conservation, supply-side options continue to play a dominant role in national water management strategies. New resource development takes many forms including: dams, aquifer exploitation, recycling and reuse, desalination, and rainwater/stormwater harvesting. Whilst the technologies to support such schemes are now well developed and understood, their application across contexts requires considerable care.

This paper provides a brief introduction to three of the supply-side options (rainwater harvesting, water recycling, and desalination) and discusses some of the implementation concerns which should guide project design and technology implementation.

2. Water Recycling

For many countries where current freshwater reserves are or will be in the near future at a critical limit, recycled wastewater is a significant low-cost resource development option for agricultural, industrial, and urban potable/non-potable uses. Analyses of the economic feasibility of wastewater reuse shows that higher investments are needed for the sewerage network. However, in countries with dense population or environmentally sensitive areas, wastewater collection and treatment is essential to protect public health and prevent environmental pollution. Thus, the additional cost for wastewater reuse for irrigation, for example, represents only a small fraction (about 30%) of the total cost for wastewater treatment and disposal (Hochstrat et al., 2006).

The driving force for developing water reuse in Europe today is the need for alternative resources together with increasingly stringent wastewater quality discharge rules and requirements for environmental protection. Hence, water reuse is growing steadily not only in water-deficient areas (France, Greece, Italy, Portugal, Spain), but also in highly populated northern European states such as Belgium, England, and Germany, as well as in tourist coastal areas and islands (Bixio et al., 2006). The integration of wastewater reuse with existing water management master plans is typically geared towards the provision of additional resources for irrigation. Indeed, irrigation of golf courses is the fastest growing reuse application in Europe. The areas where reclamation and reuse are most common at present are the Balearic Islands, Canary Islands, Spain, France, Sicily and Sardinia, Italy, and in many areas of the Mediterranean coastline.

2.1. DOMESTIC WATER REUSE

Domestic water reuse in a European context has been hampered by the lack of regulations governing quality criteria for sub-potable water use. Generally, reuse in the domestic environment is limited to gray water for toilet flushing operations. Examples of domestic reuse schemes in Europe range from single house systems, which take water from sinks, showers, and baths for reuse in toilet flushing, landscape irrigation, and, less frequently, secondary uses such as car washing and multi-house (or apartment) schemes with dual supply systems. Hotels, service stations, schools, and other public buildings are common contexts for water recycling throughout Europe and there are now several "off the shelf" systems available (Lazarova et al., 2003).

2.2. REUSE FOR IRRIGATION

The countries of southern Europe exploit recycled waters extensively for agricultural irrigation. Typical system configuration involves transfer of secondary treated effluent from a sewage treatment works (STW) to either lagoons (as in Sardinia) or to infiltration beds (as in Israel) and subsequent abstraction from lagoon or aquifer for use in irrigation. Recycling for irrigation requires consideration of three key factors: pathogenic microorganism content, salinity, and soil permeability. The first of these typically results in the need for disinfection prior to application to all applications other than pasture irrigation, where human contact is minimal. The preferred option currently appears to be chlorination, possibly because of the necessity for maintaining a residual (see Jimenez et al., 2001). Potential problems caused by salinity (Beltran, 1999) cannot realistically be ameliorated by treatment technology, since the only technologies capable of reducing substantial levels of salinity are dense membrane-based processes (reverse osmosis, electrodialysis, and nanofiltration), which are prohibitively expensive. Salinity problems must therefore be overcome through application of the appropriate infiltration (i.e. percolation) rate and selection of suitable varieties of high salinity-tolerant crops. Percolation through the soil is governed by the permeability of the soil and the propensity of the wastewater to plug the soil, which is related to the suspended solids content. Irrigation is thus inappropriate for sparingly permeable soil types, such as clays.

2.3. AQUIFER RECHARGE

There are two types of recharge schemes in common use: direct injection and soil aquifer treatment, the latter of which can be said to include the river bank infiltration schemes currently operating in the Netherlands and Germany. There appear to be two distinct philosophies for treatment. Soil percolation provides protection through adsorptive, precipitation, and biological treatment (Houston et al., 1999). The "multiple barrier" philosophy employs 2–3 sequential unit operations, such as lime dosing, filtration, and chlorination to achieve the same level of protection.

Major areas of concern regarding recharge of aquifers (Asano and Cotruvo, 2004) are, once again, pathogenic microorganisms and trace organic materials. The problems imposed by the former are substantially ameliorated both by chemical disinfection (by chlorination) and appropriate residence time and distance between the point of recharge and extraction. The long-term health risk imposed by trace organic materials is unknown, since this refers to the fraction of the total organic carbon in the wastewater, which is (a) unidentified and (b) not significantly biodegradable. The possibility exists, therefore, that these materials are to some degree carcinogenic and mutagenic, and will persist in the water until water is extracted for direct potable use.

2.4. INDUSTRIAL REUSE

Industrial applications are extremely diverse (see Cornel and Krause, 2006), making any generalization impossible. The viability of recycling is determined almost entirely by economic factors, such that the cost of supply and discharge becomes crucially important. As these costs increase, the viability of more advanced treatment processes, such as membrane technology, increase commensurately. In most of the literature identified, membrane technology appears to have been selected ahead of more conventional processes because such systems offer the advantage of:

- Product water quality which is generally very consistent and ostensibly independent of feedwater quality
- Complete and selective recovery of all components without degradation through chemical or biological processing

3. Rainwater Harvesting

Technically, rainwater harvesting systems vary in complexity. Some of the traditional systems in the developing world are no more than a pot situated under a piece of cloth or plastic sheet tied at its corners to four poles. Typical systems found in northern Europe will usually comprise a collection surface (e.g. a roof), a storage tank, and guttering to transport the water from the roof to the storage tank. Other equipment is sometimes incorporated: first flush systems to divert the dirty water, which contains roof debris after prolonged dry periods; filtration equipment; and settling chambers to remove debris and contaminants before water enters a storage tank or cistern. In Europe, the leading state for application of rainwater systems is Germany (Herrmann and Schmida, 2000) where several hundred thousand rainwater utilization installations were installed during the 1990s.

The quality of collected rainwater depends directly upon the installation techniques used. Installations that are competently designed, that have technical standards, supply rainwater that can be used for the applications named above without hesitation. Most systems can be classified into three types: gravity fed, directly pumped, and indirectly pumped.

Roof areas are the most obvious rainwater collection areas available to system designers although any hard surface, such as pavements and car parks, can also be used. The varying water collection efficiency of different types of roof design and roofing materials have led to the use of runoff coefficients, which are used to establish the proportion of the volume of rainwater that can be collected relative to the volume that falls on the surface.

Even before it hits a roof area, rainwater can become polluted by a variety of atmospheric processes. Dust and man-made emissions provide nuclei for the formation of raindrops and chemicals, such as sulfur dioxide, nitrogen oxides, and carbon dioxide, dissolve in the rainwater as it falls making it acidic. On the catchment surface itself, leaves, dust, bird droppings, oils, animal feces, and grit provide additional sources of pollution. Some types of roof surface (e.g. gravel-covered bitumen) support the growth of moss and subsequent water retention, acting as a source of debris and bacterial contamination. High pitch roofs and materials such as glass, glazed tiles, and metal encourage scouring by the rain and inhibit the buildup of potentially polluting agents. It is important to keep catchment areas and gutters clear of debris and avoid ponding to reduce the risk of contamination. The materials used for roofs and guttering can also impact rainwater quality more directly. Metals can leach into collected water by uncoated copper, lead, and zinc although copper may have some benefit in inhibiting bacterial and algal growth.

The major contamination threats in rainwater systems (Lye, 2002) are from bacteria such as *Legionella* spp. and *Pseudomonas aeruginosa*. If rainwater storage systems are exposed to light, algal growth will occur and provide a source of nutrients for continued bacterial growth. Storage tanks should therefore not be open to light, and the contained water should be stored under aerobic conditions. This can be achieved through tank design features such as introducing the feed inlet at the bottom of the tank, but above the sediment level. Storage tanks should also be vented to prevent the buildup of harmful and potentially explosive gases from the breakdown of organic debris.

A typical rainwater-treatment system in northern Europe comprises sand filtration plus ultraviolet (UV) disinfection. A sand filter can be used pre- or post-storage, and treatment efficiency is largely dependent upon bed depth and development of a thin biological film on the sand surface. UV treatment is carried out between a storage tank and cistern/usage point with most applications recording non-detectable levels of bacteria after treatment. The costs of UV systems are, however, quite high and the economic efficiency of a system will vary as a function of the volumes being treated.

The water storage tank usually represents the biggest capital investment element of a rainwater system. It therefore requires careful design – to provide optimal storage capacity while keeping the cost as low as possible. The catchment area is usually the existing rooftop, and guttering can often be obtained relatively cheaply, or it can be manufactured locally.

For storing larger quantities of water, the system will usually require a tank or a cistern. These can vary in size from a cubic meters or so (1,000 L) up to hundreds of cubic meters for large projects, but typically up to a maximum of 20 or 30 m^3 for a domestic system. There is a mind-boggling range of options open to the prospective rainwater harvester, with a wide variety of shapes, materials, sizes, and prices on offer. The amount of storage required will depend on a range of factors:

- Rainfall pattern
- Catchment area
- Demand pattern
- Retention time
- Costs of components
- Cost and availability of alternative supplies

4. Desalination

Desalination processes remove dissolved minerals (including but not limited to salt) from seawater, brackish water, or treated wastewater. Several technologies have been developed for desalination, including distillation, electrodialysis, reverse osmosis (RO), and vacuum freezing[1]. Desalination plants use seawater, brackish water from aquifers, or reclaimed water as feedwater. The two most common approaches are RO and distillation. Of more than 7,500 desilination

[1]For an authoritative overview, see Spiegler, K.S., and Laird, A.D.K., (eds.), 1980. *Principles of Desalination,* 2nd edn., Academic Press, New York.

plants in operation worldwide, 60% are located in the Middle East. The world's largest plant is in Saudi Arabia.

Desalination product water may be used in its pure form (e.g. for makeup water in power plant boilers), or it may be mixed with less pure water and used for drinking water, irrigation, or other uses. The desalinated product water is usually more pure than drinking water standards, so when product water is intended for municipal use, it may be mixed with water that contains higher levels of total dissolved solids. Pure desalination water is highly acidic and is thus corrosive to pipes, so it has to be mixed with other sources of water that are piped onsite or else adjusted for pH, hardness, and alkalinity before being piped offsite.

The RO process involves feedwater being pumped at high pressure through permeable membranes, separating salts from the water. The feedwater is pre-treated to remove any particles that might foul the membranes. The quality of the water produced depends on the pressure, the concentration of salts in the feedwater, and the salt permeation constant of the membrane. Secondary passes though additional membranes are also sometimes used when treating brackish waters. The end product typically has a solids content that ranges from 10 to 500 ppm TDS.

The distillation process involves feedwater being heated and then evaporated to separate out dissolved minerals, producing a high-quality product water that ranges from 1.0 to 50 ppm TDS. The most common methods of distillation include multistage flash, multiple effect distillation, and vapor compression.

Scaling is a significant concern with any desalination plant and plant components must be cleaned to reduce the deposit of salts on pipes, tubing, or membranes. Scaling can be reduced by introducing additives to inhibit crystal growth or by reducing operating temperatures. Both RO and distillation plant intake and outfall structures and pipelines are also prone to corrosion and fouling from marine and aquatic organisms.

The waste discharges from desalination plants contain a variety of pollutants including (obviously) salts and the chemicals used in cleaning or pretreatment (Mauguin and Corsin, 2005). Liquid wastes can be discharged directly into the ocean, combined with other discharges (e.g. power plant cooling water or sewage treatment plant effluent) before ocean discharge, discharged into a sewer for treatment in a sewage treatment plant, or dried out and disposed of in a landfill.

5. Technologies are Not Enough

In many ways, the challenges facing those who seek to exploit the potential of new water resources are very simple:

- How do we know what type of technology is needed?
- How do we decide what choice to make?
- Do we have the capacity to acquire and use a new technology?
- How can we make best use of new technology?
- Do we really understand the implications of using the technology?
- Does the new technology have implications for current systems or processes?
- What kinds of technologies might be available to us in the future?

However, if alternative water resource development and exploitation is to be tapped to its fullest potential, a variety of deployment or implementation issues will also have to be tackled. For example, water governance approaches based on the concept of Integrated Water Resources Management (IWRM) will need to formally include such alternatives. Too often, water reuse, rainwater harvesting, and desalination options are excluded from IWRM scenarios, regardless of whether such opportunities are financially or technologically realistic. The challenge here is to better inform all of the important stakeholders about viable options that bridge the tight but somewhat artificial isolation (in management terms) of water supply and wastewater-treatment systems. This lack of an integrated perspective often produces a considerable time lag between feasibility studies and their realization in practice, especially (but not only) for those regions where water and sanitation services are run by different entities.

There is also a pressing need to strengthen cooperation among stakeholders. Water service ownership structures are influenced by local circumstances, political will, legislation, institutional structure, and regulation. An analysis of successful case studies suggests that the details of ownership is not a significant issue, but does influence access to financing and cost allocation. A case in point is the Tilburg water reuse project in the Netherlands where the water supply and the wastewater services joined together to set up an ad hoc water reuse company under an administrative and legal framework that has tax advantages while at the same time having the ability to allocate funds at the lowest interest rate.

Once the case for alternative sources has been successfully made, project development is dependent on the existence of credible and legitimate standards. However, it is not always easy to obtain permits and there is a lack of clear criteria to support decisions on when such developments are desirable. This often forces public administration bodies to adopt conservative approaches.

Financing is perhaps the single most significant barrier to wider development of alternative sources. In the European Union (EU), financing of up-front costs is often provided by (local) government grants while revenue programs are financed by the end users, i.e. on a commercial basis. In order to better match project costs with acceptable volume unit cost, targeted, time-bound subsidies are important and necessary. The subsidy is generally aimed at allowing the project to operate on a commercial basis while achieving certain public program objectives. Often, water supply benefits alone cannot cover the project costs. One of the reasons is that there still exist distortions of the water supply market. Since the Dublin conference (International Conference on Water and the Environment) in 1992, the full cost recovery principle is becoming more widespread in the provision of water supply. However, even when the cost recovery principle is applied, externalities such as the scarcity of water and the marginal cost of new sustainable sources of water, are rarely accounted for. Similarly, the financial, social, and environmental burdens of effluent disposal to the environment are rarely considered in the economic analysis.

In exploring opportunities and developing options, policy makers, planners, and system designers face a number of problems which do not have simple technological or legislative remedies. For example, the use of treated and recycled wastewater in agricultural, municipal, or domestic applications is quite properly a source of concern for a variety of consumer groups. Irrespective of what conclusions the scientific evidence leads to, the impressions and attitudes which the public hold can speedily and effectively bring a halt to any reuse scheme. Consequently, strategic level decisions on the introduction of water recycling schemes need to be informed by knowledge of public attitudes and behavior towards the technologies and processes involved (Hurlimann and McKay, 2005).

Public and institutional acceptance of new water sources is a social process with a high emotive content. In many existing urbanized catchments, the water cycles actually include indirect, unplanned, and uncontrolled reuse of – sometimes even untreated – wastewater. However, facts and figures might inflame rather than convince. In some cases, the involvement of local nongovernmental organizations (NGOs) and environmental associations has proven to be a critical success factor, as the case of the Empuriabrava project in Spain clearly demonstrated (Sala and Serra, 2004).

Of particular importance are the management practices to reduce and communicate any risks to human health. Management practices relating to quality control and failure management vary considerably from region to region and even from project to project. A common trend in process operation and risk management is the adoption of extensive quality control practices and in particular the widespread use of instrumentation, control, and automation. On the other hand, despite the fact that procedures such as Hazard Analysis and Critical Control Points (HACCP) are increasingly used to direct efforts in process control and monitoring to guarantee hygienically safe water, very few surveyed projects have used them. Another interesting point is that very few projects seem concerned about emerging pollutants such as trace organics.

6. Conclusions

Even with adequate resources, high levels of commitment and plenty of experience, the deployment of new water resource schemes is undoubtedly very difficult to do well. Not least of the challenges is determining who should be involved in planning, design, construction and operation, how to involve them effectively, and how to define desired outcomes from the process. There is no foolproof recipe. Approaches need to be adapted to the needs of the particular situation and of the participants who are involved.

Growing public distrust of science and government has promoted wider and more extensive assessment of new (and old) technologies. Specifically, the belief that science is objective and free of human influence or responsibility is being increasingly replaced by a better understanding of the scientific process and of uncertainty. There is growing consciousness that scientific innovation is also shaped by human values and visions.

The belief that all relevant risks can be identified is no longer regarded as tenable. Public questioning and is being increasingly viewed as fruitful for both society and science by creating new creative tensions and forms of responsibility. The solution to mistrust is no longer regarded as educating the public, since it is now realized that well-educated sections of society frequently display most mistrust. Promotion of a two-way relationship between science and society, where scientific institutions must listen and learn to comprehend public concerns or values, is the contemporary model. Public inputs are thus not simply “opinions”, but relevant knowledge, values, and questions, which scientists may have overlooked.

Examples and lessons from previous experiences are both interesting and informative. However, they cannot be taken as models for success or failure. The particulars of circumstance, place, culture, time, and motive create an exclusive environment within which any new resource development scheme must both survive and thrive. The question which must truly be answered by those who seek to exploit the potential of new water resources is – to what extent can I utilize the knowledge from over there, over here?

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INTERNATIONAL WATER LAW AND IMPLICATIONS FOR COOPERATIVE ISRAELI-PALESTINIAN TRANSBOUNDARY WATER MANAGEMENT

ALON TAL
The Blaustein Institutes for Desert Studies, Ben Gurion University of the Negev, Israel

Abstract: Inasmuch as the interim agreements between Israel and its neighbors regarding water management are now over 10 years old, it is well to consider their efficacy and adequacy in light of the ongoing evolution of international cooperation in water management. After surveying basic principles of international water law the agreements signed between Israel and its neighbors during the 1990s, cooperative water management is reviewed and contrasted with four cases of international water agreements from around the world. The peace accords provide a surprisingly strong initial normative framework. Yet, there are several areas of cooperation that the next round of negotiations might consider to enhance the institutional and substantive effectiveness of water accords as a basis for ameliorating conflict and ensuring the sustainability of water management in the region.

Keywords: water management; international law

1. Introduction – International Environmental Agreements – Potential and Limitations

Over 500 international environmental conventions currently help to regulate the global commons. Some 80% of these have been ratified since 1972; the vast majority are regional in nature. Among the achievements that can be attributed to international environmental law are:

- A 90% drop in CFC production (US EPA, 2001)
- A precipitous decline in whale take from 66,000 (1961) to 1,500

C. Lipchin et al. (eds.), Integrated Water Resources Management and Security in the Middle East, 213–236.

- The return of severally previously endangered species (e.g. elephants) (Christie, 1993)
- A reduction in air pollution concentrations in Europe and North America

The management of transboundary water resources is a particularly critical area of modern international environmental law. If agreements concerning travel and transport are included, the number of hydrologically related international agreements is even more staggering: 3,600 international treaties relating to water resources have been drafted during the last 1,200 years (Birnie, 2002). Since 1814, some 600 conventions deal with non-navigational aspects of water management (Kiss, 2000). The ability of so many nations to agree on cooperative frameworks for water management suggests that water is indeed a greater force for agreement than conflict. Not only do international agreements reduce the tensions associated with competing claims in transboundary watersheds, but in the environmental sphere, international law often serves to leverage national initiatives to reduce polluting activities and create sustainable policies for water management.

Like all international conventions, international environmental agreements regarding water resources are subject to the basic norms set forth in Vienna Convention on the Law of Treaties (1969). No less important for their successful implementation are the practical dynamics of international relations that tend to effect agreements addressing transboundary natural resource problems (Palmer, 1992). These include:

- The need to reach a consensus position in negotiations and the generic (and often vapid) framework agreements that serve as an initial basis for international cooperation.
- Frequently the specificity of the agreement is enhanced through subsequent protocols and annexes.
- Oversight of conventions is usually conducted via periodic conference of the parties and a secretariat, whose budgets and mandate are typically inadequate for the task of expediting compliance among parties to the convention.
- Domestic ratification often lags behind the actual commitments made at the time of the signing of the convention.
- Compliance is based on trust and the principal of *Pacta Sunt Servanda* (good faith in meeting state commitments) although reporting procedures often serve as a valuable tool for prodding nations to take action. Adjudication between sides for violation or noncompliance, in any event is exceedingly rare.

- The creation of a scientific advisory framework often offers a mechanism for overcoming political disagreements and for maintaining the technical integrity of the agreement as new data and understanding emerge.

Concerns about the efficacy of international environmental agreements generally focus on the difficulty associated with enforcing them. Formal adjudication requires the consent of parties to the agreement. Even then, an aggrieved party must muster the political will to prosecute. Several international environmental agreements do contain trade sanctions for noncomplying parties. For example, the Convention on International Trade in Endangered Species of Wild Fauna and Flora of 1973 (CITES) creates a mechanism for suspending wildlife trade with countries who are out of compliance with treaty's terms. Such sanctions have indeed been invoked against China, Italy, Greece, and Thailand (Tierney, 1998). More common than the use of a stick involves the "carrot" associated with international assistance from agencies like the Global Environmental Facility (GEF) that can be selectively withheld from bad actors (GEF, 2006).

An evaluation of different international agreements designed to regulate transboundary watersheds, should also be mindful of the broader normative framework of international law which facilitates cooperation and expedites agreement. Article 3 of the *Statute of the International Court of Justice* in The Hague defines a hierarchy of legal sources that define the substantive rules and principles of international law (Shaw, 2003). Ranked from top to bottom, these include:

- International conventions (agreements between nations)
- Customary laws governing international activity
- General principles of Domestic Law
- Judicial decisions by international courts and arbitration boards
- Resolutions or the "Soft Law" where general principles are proclaimed in resolutions by international bodies or at gatherings.

In the context of transboundary water resources, there is a clear evolution in the substantive orientation of international law as reflected in the above sources (Blatter, 2000). Prior to the 1972 Stockholm Convention on the Human Environment, the primary emphasis that emerged from natural resource treaties and their adjudication was the protection of state sovereignty. From the regulation of seal hunting to ensuring the free travel and commerce in international waters, protecting the global commons was considered less important than ensuring that countries enjoyed unfettered use of their own resources, unlimited by their neighbors' interests and concerns (Tal, 2006).

All this has changed with the advent of modern international environmental law. Treaties seeking to protect the ozone layer, reduce international trafficking of hazardous substances or protect species unabashedly dictate domestic national policies (Birnie, 2002). In the water realm, limitations on state activities go beyond the contractual sphere of multilateral conventions. Several decades of agreements and the steady integration of legal doctrines have established a series of general precepts that today can be perceived as enjoying the status of "customary law", creating a context for the formulation of new agreements, as well as their subsequent implementation (Eckstein, 1995).

2. Basic Principles of Water Law

The most fundamental question that traditionally arises in international water law discourse involves sovereignty – or put simply: "Who enjoys rights to the water?" Traditionally there have been competing perspectives on what constitutes the binding *customary*, international legal principles. The myriad substantive positions espoused not so coincidentally, tend to be consistent with the particular national interests of the advocate.

On one extreme is the position of *Riparian Rights* that holds that water rights should be assigned on the basis land ownership along a stream. This position is often referred to as the *Harmon Doctrine* after the somewhat bellicose US Attorney-General who waxed enthusiastic when asked to advise his government regarding its conflicts with Mexico over water rights. According to this perspective, water rightfully can be used by those upstream who have access to it. In 1895 Judson Harmon posited that: "The fundamental principle of international law is the absolute sovereignty of every nation as against all others, within its own territory... all exceptions, therefore, to the full and complete power of a nation within its own territories must be traced up to the consent of the nation itself." Turkey and other nations that sit "upstream" conveniently agree that their past willingness to allow water to flow to downstream riparians in no way implies that they are enjoined from utilizing these sources in the future (Eckstein, 1995).

On the opposite extreme is the position of *Historical Rights* or *Natural Flow*. This stance holds that if a party or individual has enjoyed access to water which flowed into an area under her control, she is fully entitled to continue to receive this water. Historic use essentially creates a property right. Accordingly, any upstream diversion which reduces this access would be considered illegal (Hall, 2004). Not surprisingly, downstream riparian countries, as disparate as Egypt and Israel, who may be at odds regarding certain aspects of Middle Eastern politics, agree on this principle with regards to access to the Nile River and the Mountain Aquifer respectively (Aberra, 2005).

It did not take long to realize that both of these extreme positions would frequently lead to "unjust" results, or at least results that left large populations without an adequate framework for supplying basic water needs (Blatter, 2000). More moderate views emerged based on a "golden rule" of environmental consideration and conduct that was formally endorsed by the international community in the 1972 Stockholm Declaration. The United Nations Conference on the Human Environment at Stockholm was the first global gathering of leaders to seek multilateral international governance in response to transboundary environmental problems. Principle 21 of the Declaration holds that States have a sovereign right to exploit their own resources as long as their activities: "do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction" (Linner, 2003). Or as the playwright George Bernard Shaw glibly quipped: "Your rights end – where my nose begins."

Already, comparable legal doctrines in the area of water rights were attracting support in the expert community. The notion of Absolute Riverain Integrity and a Community of International Waters had already been advocated by scholars who felt that rivers basins and water bodies needed to be addressed as a holistic unit. According to this view, political sovereignty should be a secondary factor in the actual management decisions. In practice this meant that no riparian should act without the agreement of others. While this view was viewed as useful in the context of a federal system of government, in the rough and tumble of international relations, it was considered somewhat naïve and impractical (Dellapenna, 2001).

An alternative principal of *Limited Territorial Sovereignty* was not altogether different in its implications, but managed to receive a greater degree of international recognition. Relying on the Latin adage:*sic utere tuo ut altenum non laedas* (use property in a way that doesn't harm others) the needs of other states needed to be taken into account before unilateral action could be taken. Transboundary water resources could surely be utilized so long as it did not result in substantial harm to water interests of other riparians.

This position enjoyed support in a formal adjudicatory context during the 1957 Lake Lanoux Arbitration that resolved a water conflict between France and Spain. At issue was the French intention of establishing a hydroelectric plant that would divert waters away from Spain's Carl River. Spain opposed the project on the ground that it would affect the entire basin. The decision held that while France's extraction did not violate international law, Spain was entitled to be consulted prior to modification of the river. However, the ruling was anything but a Spanish victory. In rejecting Spain's claims, the arbitration ultimately rejected the granting of veto powers to any given riparian, even as it objected to unilateral activities that affect the hydrological reality of neighbors without meaningful consultation (Kiss, 2000).

The “middle of the road” position had already received an important endorsement in the “Helsinki Rules” that were approved in 1966 by the International Law Association (ILA). The Rules constituted a broad effort to formalize the principles of international water law. Yet, it succeeded in doing so in only the most general or of terms. The definition of an international drainage basin given under the Rules was clear enough: “a geographical area extending over two or more States determined by the watershed limits of the system of waters, including surface and underground waters flowing into a common terminus” (International Law Association, 1966). The assignment of rights and responsebilities within these watersheds, however, was less clear.

The Helsinki Rules are most notable for their articulation of a new “reasonable and equitable” standard for determining allocation in transboundary watersheds: “Each basin state is entitled within its territories to a reasonable and equitable share in the beneficial uses of the waters in an international drainage basin.” Yet, as always in international law, the devil is in the details.

Over the years the concept succeeded in gaining “consensus status” because it could easily be interpreted favorably by all parties in disputes. Indeed, the Rules themselves qualify the concept as a principle whose application cannot be readily defined nor predicted. Accordingly, Article 5 states that: reasonable and equitable “is to be determined in light of all relevant factors in each case.” To be fair, Article 5 does set forward a list of “relevant factors” that need to be considered in determining what is reasonable and equitable. They include:

- Basin geography
- Basin hydrology
- Climate
- Past and existing utilization
- Economic and social needs
- Dependence of population on basin waters
- “Comparative costs of alternative means of satisfying economic and social needs of basin states,
- Availability of other resources,
- Avoidance of unnecessary conflicts, and
- Degree to which needs of basin state are satisfied.”

But without any clear ranking of these factors, scholars were left with a list of amorphous inclinations that were later amorphously interpreted in the Helsinki commentaries. It is generally accepted that the general Helsinki perspective on water includes a preference for domestic use of water over alternative uses, along with a general recognition of the significance of past and present uses relative to future ones (Sergent, 1997). (An alternative position, that prefers future uses, presumably would provide disincentives for present development.)

The next significant landmark in the evolution of international water law was the passage of the UN Convention on the Non-navigational Uses of International Watercourses. Adopted in September 1997 by the UN General Assembly, it was the culmination of 25 years of efforts and negotiations to better characterize internationally accepted principles of water law. The convention contains 37 articles which address the myriad areas that modern water policy addresses. Hence there are provisions regulating everything from flood control to water quality, erosion, sedimentation, and saltwater intrusion. While the treaty focuses on surface water, it does contain groundwater components.

The treaty reiterates Helsinki's fundamental axiom of allocation, obliging the UN members to use international watercourses in ways that are "equitable and reasonable". Yet, it also includes certain basic concepts of modern environmental policy. Concepts of "good neighborliness" find expression, including an obligation for cooperation and information sharing. Significantly, Article 5 adopts a precautionary posture calling on countries to take all appropriate measures to prevent the causing of significant harm to other states by any misuse of transboundary water resources.

A main question with which drafters of the UN wrestled was whether to embrace a "drainage basin" perspective or not. At issue, to a large extent was making groundwater subject to the standards of care mandated for riparians of surface water bodies. There was a strong lobby against inclusion, calling it a departure from traditional "channel based approach". Predictably, the breakdown of advocates and opponents split according to national hydrological interests or between "upstream" and "downstream" users. Notwithstanding the clear middle ground staked under the Helsinki Rules, upstream riparians argued for unrestricted territorial sovereign with downstream users advocating broader drainage basin approach (Schwabach, 1998).

The UN International Law Commission ultimately rejected this basin approach in favor of a more narrow definition for a watercourse: "a system of surface waters and groundwaters constituting by virtue of their physical relationship a unitary whole and normally flowing into a common terminus."

In a word, the ILC sought to establish a definition that linked groundwater to surface flow. Specifically the treaty holds that water unrelated to surface water "should not be included because it lacks a physical relationship with surface water and does not form part of a unitary whole."

Yet, hydrological reality on (and under the ground) is far more complex than that which the ILC's would like to regulate. Gabriel Eckstein a hydrologist and legal commentator identified six different transboundary aquifer dynamics, which would not be captured by the simplistic ILC approach (Eckstein, 2005).

The Palestinian/Israeli dispute over the Mountain Aquifer is a fine example of the UN Convention's limitations. The Mountain Aquifer to be sure is transboundary, where recharge largely takes place in the highlands of Judea and Sumaria (the West Bank) but where wellheads are mostly confined to the Israeli lowlands. But the aquifer does not have a "common terminus". Hence it would seem that the UN Convention is not be applicable for resolving the dispute over this particular resource or for any other non-charging fossil aquifers.

Recognizing that the present definition was inadequate, in 2002, the ILC appointed Ambassador Chusei Yamada of Japan to further negotiate the subject of shared natural resources. Yamada brought together an interdisciplinary panel that advised his group on the nuances of managing transboundary groundwater systems, but to date, no formal treaty amendments have been adopted.

A discussion of relevant international water law must include the *Bellagio Draft Treaty.* Accordingly, a significant academic effort in the field took place during the 1980s when legal scholars attempted to move the area of "customary" law forward and define accepted principles for the management of transboundary aquifers. Beginning in 1977, over an 8-year period, a model treaty was drafted, largely motivated by the historic tensions that existed between the USA and Mexico over their shared aquifers (Rodgers, 1985).

The primary notion of *Belagio* is that of consensual allocation:

"water rights should be determined by mutual agreement rather than be the subject of uncontrolled, unilateral taking and that rational conservation and protection actions require joint resource management machinery" (The Bellagio Draft Treaty, 1989).

Among Belagio"s innovations are the creation of a concept of an "underground environment" that includes "conjunctive use" of surface groundwater in border areas. Moreover, "Transboundary Groundwater Conservation Areas (TGCAs) are to be established, referring to contiguous regions that should be jointly managed during drought in which allocations can shift based on competing needs.

Among the critical innovations of the treaty are:

- *proactivity*: it anticipates solutions for complex transboundary problems and does not wait for the conflict to 'come home to roost';
- *ground/surface water interface*: it links groundwater management with both water supply and water quality;
- *environment and equity focus:* the treaty places less emphasis on allocation than did previous agreements and raises the profile of equity and quality preservation;
- *ecological orientation:* the treaty includes riparian ecology, system management, as well public health considerations;

- *obligations:* Belagio creates binding requirements to protect the underground environment; and
- *monitoring:* parties are expected to provide 'reliable data and information'.

3. Agreements Between Israel and its Neighbors

While international multilateral treaties and international customary law have influence on the management of transboundary watersheds, ultimately it is the specific obligations taken on by riparians that determine the normative framework (and the ultimate success) of cooperative efforts in water management and their ability to ameliorate or even eliminate conflict (Dellapenna, 1994). For example, the USA and the World Bank responded to an increasingly explosive dispute between India and Pakistan over the allocation of the waters in the Indus River, forced both parties to the table and after 8 years of negotiations produced the 1960 Indus Waters Treat (Biswas, 1992). Since that time, India and Pakistan have hardly been on the best of terms, but hydro-political tensions surrounding the Indus have subsided and remained dormant.

In the case of the Middle East, the actual agreements signed on the area during the 1990s were undoubtedly influenced by the evolution of international water law. With the July 1992 election of a government led by Israel's Labor Party, new initiatives to resolve the conflict between Israel and its neighbors were launched. Culminating in the "Oslo Accords", after the Norwegian capital where much of the initial negotiations took place, in rapid succession Israel signed a peace treaty with Jordan and interim agreements with a newly created Palestinian Authority (Gleick, 1994). While often the dynamics of the negotiation relied more on age-old mid-east bargaining rituals than legal treaties, the agreements that were ultimately produced create a strong basis for ongoing cooperation (Feitelson, 2000). Indeed, these agreements produced some of the most detailed water pacts ever to appear in an agreement whose objective, primarily, was the cessation of a political/military conflict.

3.1. THE ISRAELI-JORDANIAN WATER AGREEMENT

Annex II regarding "Water Related Matters" was promulgated pursuant to Article 6 of the Israel-Jordan Peace Treaty that was signed at the Aqaba/Eilat border crossing on October 26, 1994 (Treaty of Peace, 1994). The annex opens with delineation of specific "seasonal" allocations to be granted to each side from water in the Yarmouk River. Jordan concedes to Israeli the pumping of an additional 20 million cubic meters (MCM) from the Yarmouk during the rainy winter season in return for an Israeli concession to deliver water during the dry, summer months (between May 15th and October 15th). Similarly, in return for the additional water that Jordan concedes to Israel in winter, Israel granted an additional 20 MCM to Jordan during the summer months to be taken from the Kinneret "directly upstream from the Deganya gates" on the river. The ongoing costs of the transfer are to be borne by Jordan. Moreover, Jordan is entitled to "store" water that arrives during the rainy months in the Kinneret, that can then be delivered during the summer when supply is low.

The agreement goes beyond implicit acknowledgement of historic rights and the de facto past understandings regarding allocation from the 1950s, by specifically recognizing Israel's right to maintain its current uses of the Jordan River waters. While Jordan is entitled to an annual quantity equivalent to that of Israel, this is contingent upon its not harming the quantity or quality of historic Israeli uses. An another unanticipated "generous" gestures of the peace agreement was King Hussein's flexibility with regard to existing Israeli wells that fell within lands in the Arava Valley which under the territorial agreement, were to be transferred to Jordan. Israel is entitled to continue to use these wells and even increase the amounts extracted from them, assuming that such pumping does not appreciably reduce the yields or the quality of the ground water systems.

Article III of the Annex contains provisions that are to regulate activities that can affect water quality. Both countries undertake to protect the quality of the Jordan and Yarmouk Rivers, as well as the groundwater in the Arava Valley and their own water systems against pollution or contamination, as well as to prohibit unauthorized allocations. Monitoring stations are to be established along the border; these are to be operated by the Joint Water Committee (JWC). Waste waters discharged into the rivers are to be treated to a standard that allows for "unrestricted agricultural use" – and a 3-year timetable set to meet these standards. Rather than setting a single numeric water quality standard for waters that are transferred under the agreement, the Annex simply stipulates that the quality of water supplied from one country should be no different than the water it uses in the same location. As to the natural saline streams that Israel diverts from the Kinneret Lake into the southern Jordan, the Annex creates a 4-year timetable at whose end, the waters should be desalinized.

From the substantive perspective, the agreement appears to embrace the concept of absolute riverain integrity or good neighborliness in activities that affect a shared resource, proscribing unilateral actions. Hence, Article V prohibits artificial changes in the course of the Jordan or Yarmouk Rivers without mutual agreement. And each country commits itself to informing the other 6 months prior to undertaking any projects that might change the flow or the water quality of the rivers. The agreement also includes a commitment to cooperate in developing plans to increase water supplies and improving water use efficiency.

Institutionally, Article VII of the Annex creates a JWC, whose role it is to ensure that the new commitments to cooperation are implemented. For instance, the JWC is to discuss any projects that might cause adverse impacts and suggests measures to mitigate them. The countries also create a blanket obligation to "exchange relevant data on water resources" through the JWC.

The Committee is to be made up of three members from each nation (there is no international participation) but no stipulation is made to their professional qualification. The Annex authorizes the Committee to invite experts and/or advisors as may be required and form specialized subcommittees and assign them technical tasks. Two specific subcommittees are to be established according to the Annex: a northern and a southern subcommittee, for the "management on the ground of the mutual water resources in these sectors." The committee was indeed created, but has not continued to meet regularly and the subcommittees never became an important factor in ongoing management.

3.2. THE ISRAELI-PALESTINIAN WATER AGREEMENT

While the initial agreement between them related to the creation of Autonomy in Gaza and Jericho and was reticent with regards to most water issues, Israel's interim agreement with the Palestinians signed on September 28, 1995 in retrospect offers a fine basis for cooperation. The issue of water quantity allocation was largely left to be resolved in the negotiations over the final status (Interim Agreement, 1995). But Article 40 of Annex III to the agreement contains much more than the rudiments of a transboundary water treaty. Indeed a JWC created under section 11, is empowered with broad authorities to make managerial decisions, exchange information, grant licenses for wells, monitor, and resolve disputes. The committee, comprised of an equal number of Palestinian and Israeli members, continues to meet and function, despite the almost complete breakdown of all other political structures created under the Oslo accords. The JWC is given a broad menu of authorities with which to operate. Its mandate includes:

- Coordinated management of water resources
- Coordinated management of water and sewage systems
- Protection of water resources and water and sewage systems
- Exchange of information relating to water and sewage laws and regulations
- Overseeing the operation of the joint supervision and enforcement mechanism
- Resolution of water- and sewage-related disputes

- Cooperation in the field of water and sewage, as detailed in this Article
- Arrangements for water supply from one side to the other
- Monitoring systems
- Other issues of mutual interest in the sphere of water and sewage

The most important breakthrough of the agreement is resolution of the self-defeating dynamic that emerged during the initial period of negotiations regarding water. The Palestinian position, always passionate in its embrace of principles of "riparian use" was resolute in its demands that Israel return all waters in the Mountain Aquifer that it had appropriated from its rightful Palestinian owners before and after Israeli occupation of the West Bank in 1967. The Israeli position, based on its longtime faith in the theology of historic uses, rejected the notion that its utilization of waters from the Mountain Aquifer was in contravention of international law. Ultimately, it argued, the objective of negotiations should be expansion of existing water resources anyway, as both entities were extremely water stressed, by all international definitions of water scarcity. This somewhat circular dynamic ("you stole our water" – "no we didn't" – "yes you did") produced little progress but did succeed in exacerbating tensions and enmity (Tal, 2002).

Article 40 therefore contains a welcome compromise in this regard. Israel on the one hand recognizes Palestinian rights to much of the Mountain Aquifer: "Israel recognizes the Palestinian water rights in the West Bank. These will be negotiated in the permanent status negotiations and settled in the Permanent Status Agreement relating to the various water resources." At the same time the Palestinians acknowledge that: "Both sides recognize the necessity to develop additional water for various uses."

Most happily, with regards to water quality, the agreement goes beyond generalities and declarations. The Palestinian future needs are estimated as reaching 70–80 MCM of water per year. As an interim measure, until a final agreement provides a comprehensive resolution to the issues in dispute, Israel agreed to grant an additional 28.6 MCM annually to the Palestinian Authority. Basically deemed a "humanitarian" gesture, the objective of this concession was to ameliorate the acute shortages that existed. This transfer of water rights is broken down in a schedule of specific deliveries to be made to different regions of the West Bank. The Palestinians also took upon themselves obligations to dig additional wells in areas where additional water potential exists.

No less impressive is the general commitment to coordinated action to preserve water quality. The sides set forth a long list of principles according to which management of water and sewage resources were to be coordinated. These include:

- Preventing the deterioration of water quality in water resources
- Using water resources in a manner that ensure_sustainable use in the future, in quantity and quality
- Avoiding overpumping: (*Adjust utilization of resources according to variable climatological/hydrological conditions.*)
- Taking all necessary measures to prevent any harm to water resources, including those utilized by other side
- Treating, reusing, or properly disposing of all domestic, urban, industrial, and agricultural sewage and prevent any harm to the systems

From the perspective of international legal theory, the most impressive part of the agreement is the concrete commitment made to joint compliance and enforcement actions. The "JSETs" – or "Joint Supervision and Enforcement Teams" created under section 17 of the agreement constitute an unexpected innovation. The joint Palestinian/Israeli inspection teams' role is detailed in schedule 9 of the agreement. Each team is comprised of no less than two representatives from each side who patrol in parallel vehicles. The teams are given authorities to rectify a host of environmental infractions – from pirate extractions, to contamination of aquifers and even ensuring" operation and maintenance of systems for collection, treatment, disposal, and reuse, of domestic and industrial sewage, of urban and agricultural runoff, and of urban and agricultural drainage systems."

The JSET framework offers a refreshing level of specificity and tangible commitment by parties in an international agreement regarding water. In fact, even 10 years after its establishment, such a pragmatic approach to enforcement is unique in the international arena. While political unrest has temporarily neutralized the JSET activities, even during the most turbulent of times politically, the JWC continued to convene, offering a reliable and viable basis for dialogue and joint decisions (Tal, 2004).

In short, the agreement forged by Israeli and Palestinian diplomats over a decade ago, at least formally, remains legally binding and still constitutes a surprisingly innovative and effective instrument for ensuring cooperation. When one compares the existing Israeli/Palestinian agreement to other transboundary water agreements (e.g. the Incomati Basin agreement between South Africa, Swaziland, and Mozambique, the Mexican/US arrangement regarding the Rio Grande, or the Lake Peipsi arrangement reached between Estonia and Russia) it seems to provide a reasonable basis for continued cooperation.

4. Models for Managing Joint Watersheds: Lessons for the Middle East

Following this cursory discussion of the agreements regarding water management between Israel and its neighbors, a review of four legal frameworks in transboundary watersheds is briefly presented. These cases can serve as models, whose experience may be instructive. They include:

- The joint management by the USA and Canada of the rivers that transect their borders
- The agreement between Estonia and Russia to protect Lake Peipsi
- Efforts between riparians in Southern Africa to manage the Incomati Basin
- The evolution of the US and Mexican agreements in managing the Rio Grande

Each of these stories offers interesting insights and ideas that might be integrated into a final Israeli/Palestinian agreement or an upgraded Israeli/Jordanian accord in the area of sustainable water management.

4.1. BILATERAL MANAGEMENT OF TRANSBOUNDARY RIVERS – USA/CANADA

At the advent of the 20th century, tensions were growing between the USA and Canada over the water rights to several rivers that crossed their border. With the UK sitting in, by 1909 an agreement was reached that took the title: *Treaty Relating to Boundary Waters Between the United States and Canada* The treaty relied heavily on an institutional resolution of disputes.

Specifically an International Joint Commission (IJC) was created within the treaty framework. The IJC is comprised of six commissioners (three from each country) and charged to act "impartially". The goal was to create an independent managing body that could execute the agreement objectively, without being divided according to purely national interests. To ensure this outcome, the commissioners were granted immunity in both countries for any decisions they made in the IJC context. Empowering the body even further, the Treaty declares that decisions of the IJC cannot be appealed and can only be revoked by a joint US/Canada agreement (Hall, 2004).

The IJC's ostensible success in resolving water-related disputes can be attributed to its operational orientation which has emerged over time. The Commission indeed has achieved a high level of impartiality and whenever possible, it seeks consensus (Parrish, 2005). When disputes arise, all interested parties are given the opportunity to be heard. In environmental matters, the IJC has come to adopt policies based on a series of environmental principles:

- Principles of sustainable development
- An ecosystem approach towards water management
- A commitment to elimination of persistent toxic substances
- Reliance on sound science, and when in doubt, adoption of the *precautionary principle* as a guideline

Historically, it is hard not to be impressed by the institutional stamina and the Commission's ability to remain relevant, despite the geopolitical, economic, and ecological vicissitudes in the two countries. In 1931, it was the IJC that oversaw the historic arbitration that has come to be called the *Trail Smelter Arbitration* (1938) in which it recommended emission reduction for air polluters. As the first meaningful transboundary air pollution case in the world, the ruling has become required reading in any international environmental textbook or treatise.

Over a decade later, the IJC suggested a clear framework for allocating the benefits derived from the Columbia River and in 1961 brokered the Columbia River Development Treaty. During the 1970s, the IJC shifted its focus to the Great Lakes region where it shepherded a Great Lakes Water Quality Agreement between the countries in 1972. In 1978 the agreement was expanded to include persistent toxics. Ten years later, in 1987, the IJC was drafted to review "Remedial Action Plans" to reduce toxic substances in 43 areas of concern around the lakes.

In recent years the IJC has been as active as ever. In 1997, the US and Canadian governments asked the Commission to prepare a report detailing the upcoming environmental challenges that would affect transboundary water management during the 21st century. The list compiled provides an agenda for future cooperation that should be relevant to Israeli/Arab Joint Water Commissions:

- Population growth and urbanization
- Climate change
- Economic expansion and energy demands
- Technological development
- Environmental awareness

The IJC has not passively waited for crises to emerge from neglected problems, but actively lobbied for solutions, for example the establishment of joint watershed boards to manage the St. Croix, Rainy and Souris rivers (Hall, 2004).

In retrospect, the IJC has been a lasting influence for environmental cooperation in the northern hemisphere. Like any public body it has not escaped criticism. Inadequate public participation and the lack of sufficient authority are among the more common critiques (Hall, 2004). Nonetheless, the IJC has identified over 130 disputes that it helped reconcile or avert completely. Even if the actual number of cases where meaningful progress was made is only a fraction of this, it would still constitute a highly successful venture in transboundary water management.

There are many lessons that bilateral, final agreements between Israel and its neighbors might glean from the IJC experience. These are primarily in the area of institutional identity. The existing Israeli/Palestinian – Israeli/Jordanian Joint Water Commissions are dominated by cautious government officials whose loyalties are obvious and whose level of initiative is limited. After all, their domestic responsibilities are daunting enough. Making the leap towards true "holistic" watershed management, may require the sort of independence that the IJC enjoys and insulation from political influences.

4.2. LAKE PEIPSI/(CHUDSKOE-PSKOVSKOE) AND THE ESTONIAN-RUSSIAN TRANSBOUNDARY WATER COMMISSION

Lake Peipsi is the world's fourth largest lake and by far the largest transboundary surface water body in Europe. Located on the border of Estonia and the Russian Federation, the Estonian part of Lake Peipsi contributes 89% of the country's surface freshwater, as well as providing some 95% of the country's fish catch from fresh waters. The breakup of the Soviet Union necessitated international negotiations to ensure sustainable management of the Lake (Vinogradov, 1996). The paramount ecological challenge was the prevention of eutrophication due to excess loadings of nutrients, with the primary contaminants in the lake attributable to polluted river water and precipitation.

To oversee cooperation in this regard, the Estonian-Russian Transboundary Water Commission was established in 1997 between the Republic of Estonia and the Russian Federation (UNESCO, 2002). The Commission quickly became the primary actor in managing Lake Peipsi. The list of authorities granted the Commission reflects the willingness of both parties to sacrifice authorities associated with national sovereignty in order to ensure the responsible management of the lake. Among the authorities granted to the Commission are:

- Exchange of monitoring data between the parties
- Priorities and programs for sustainable use of transboundary waters
- Common indicators of quality for transboundary waters, along with the methods of testing and analyzing water
- Cooperation between executing agencies, local governments, scientific, and public interest organizations
- Communications related to use and protection of waters

The Commission has established formal mechanisms for development of cooperation with local authorities, nongovernmental organizations (NGOs) and stakeholders, which allows local organizations and stakeholders in the region to participate directly in the work of the intergovernmental commission. In practice, relatively few regional NGOs are actively involved in the work of the Commission. This is largely due to the limited resources and capacity of local organizations. Without external financial support, it is unlikely that the NGO community will fully realize its potential role as a contributor to a transboundary management framework. Yet, groups such as the Peipsi Center for Transboundary Cooperation (CTC) and the Council for Cooperation of Border Regions, have already shown the potential for fruitful cooperation with local authorities and stakeholders in influencing regional development projects as well as on educational, research, and social projects in the region. The Peipsi CTC is also actively involved in the work of the Estonian-Russian Transboundary Water Commission (UNESCO, 2002).

Another important aspect of the Peipsi experience is the involvement of commercial interests in the joint management program. For example, regional authorities and businessmen are trying to reestablish passenger and cargo transport across the lake. Drinking water supply from the lake is another area where commercial interests are now involved in joint ventures. A critical stage in the transboundary management strategy involves the preparation of a Lake Peipsi Management Plan. A joint effort drafted by the Estonian and Russian governments, regional and local authorities as well as private and public companies – the plan is slated for completion 2007.

The water agreements between Israel and its neighbors have much to learn from the experience at Lake Peipsi. Chief among these is the creation of a regional master plan that proactively can help diffuse and depoliticize complex water and potentially explosive issues. The emphasis on joint monitoring of water quality is another area where present agreements are silent. The encouraging of joint commercial interests, particularly in the area of drinking water delivery offers an opportunity to create confidence-building measures in the private sector, using the profit motive to supplement the general "impulse for peace" which is often tenuous or insufficient to bring potential partners together. Finally, the NGO involvement and the outreach effort to engage civil society is a far cry from the relatively insulated approach of Israeli and Jordanian/ Palestinian government officials.

4.3. THE INCOMATI BASIN: COOPERATIVE WATERSHED MANAGEMENT BETWEEN SOUTH AFRICA, MOZAMBIQUE, AND SWAZILAND

The Incomati Basin offers an example of where efforts to jointly manage a transboundary water resource are hampered by lack of harmonization between national legislative frameworks and the absence of an accountable international commission to see implementation through. In 1997, both Mozambique and South Africa adopted the UN Convention on the Law of the Non-Navigational Uses of International Watercourses as a basis for management of the Incomati Basin (Lindstrom, 1997). Swaziland, the third riparian in the catchment, however, was not party to the agreement.

Immediately, gaps emerged between the expectation of the Southern African Development Community (SADC) protocol and the existing framework for managing the watershed. As a downstream riparian, in 1999 Mozambique perceived the UN Convention as a basis for strengthening the regional SADC Protocol on Shared Watercourse systems. The amendments, proposed by Mozambique representatives established a new version of the SADC Protocol, integrating the principles found in the UN Convention, highlighting both environmental and downstream needs (Leestemaker, 2001).

The amended SADC Protocol essentially adopts a watershed perspective, embracing the "territorial integrity" of the Incomati watercourse as a single hydrological unit. Unfortunately, domestic law in the three countries is fundamentally different, complicating implementation of the agreement. For example, the central role of the King and traditional chiefs in Swaziland focuses on amorphous concepts of responsibility and ownership, and avoids any specifics regarding water rights and allocation. Moreover, South Africa has begun to decentralize its water management system, in contrast to Mozambique's strict "state ownership" and organization. Another obstacle to an integrated basin-wide management program is the lack of symmetry between the small, disorganized, indigenous local users and the large industrial (frequently "multi-national") corporate users, such as sugar and electric companies or agribusiness (Turton, 2002). Also, without very clear provisions in national legislation to ensure environmental protection, and a stronger regulatory presence by central governments among the riparians the prospects for treaty implementation are bleak.

When considering the lessons of the Incomati experience, it is well to remember the relative asymmetry that exists between Israel's economic capabilities and that of its neighbors. While Israel enjoys a per capita income which exceeds US $17,000/year, resources in Jordan are a fraction of that and after 6 years of political turbulence, the Palestinian sector is practically destitute. Without providing resources for the infrastructure necessary to meet obligations in water agreements, real progress cannot be anticipated. The lack of follow-through in the commitments in the Jordanian Israeli water agreement are proof that resources (and to some extent political will) provide real obstacles to turning ambitious transboundary accords into reality on the ground.

4.4. COOPERATIVE WATER AGREEMENTS ON THE RIO GRANDE

The US experience with its southern neighbors is somewhat less successful than that transpiring on the northern, Canadian border. On the Mexican border, an institutional solution was again sought to resolve the inevitable conflict surrounding allocation of the two great transboundary southern rivers: the Rio Grande and the Colorado. According, the International Boundary and Water Commission (IBWC) came into being pursuant to the provisions of two key legal instruments: The Convention of 1889, created the International Boundary Commission (IBC), while half a century later the 1944 Water Treaty (The Treaty Relating to the Utilization of Waters of the Colorado and Tijuana Rivers and of the Rio Grande) changed the Commission's name to the name of IBC to IBWC. The key instrument that the Commission seeks to implement is the somewhat prolix: "Convention between USA and Mexico Providing for the Equitable Distribution for the Waters of the Rio Grande for Irrigation Purposes (1906)".

This treaty defines allocation for the USA from the Rio Grande (and for Mexico from the Colorado). The 1944 treaty allocated some of 350,000 acre-feet of flow annually from the Rio Grande. This allocation included "Extra-ordinary Drought" provisions – (made up over 5 years). At the same time, water delivered to Mexico from the Colorado River was to reach 1,500,000 acre-feet/year (Mumme, 2005).

The 1944 treaty confers upon the IBWC the status of an international body. It also attempts to ensure the professional character of the Commission by stipulating that both the Mexican and American head must be engineers. The Commission is to initiate joint actions or implement joint agreement by Governments. Its substantive mandate is clearly set forward in a list of specific objecttives (Hall, 2004). These are defined as:

- Distribution of the waters of Rio Grande and of the Colorado River between the two countries
- Regulation and conservation of Rio Grande waters for use by the two countries through joint construction, operation and maintenance of international storage dams and reservoirs, as well as plants for generating hydroelectric energy
- Regulation of the Colorado River waters allocated to Mexico
- Protection of lands along river from floods by levee and floodways

- Solution of border sanitation and other border water-quality problems
- Preservation of Rio Grande and Colorado River as international boundary
- Demarcation of the land boundary between the USA and Mexico

The mechanics of the IBWC reflect the pragmatism born of a century of work. Each country maintains separate, local headquarters with its own staff. The Commissioners themselves constitute a functional team, meeting weekly and maintaining daily contact. The cooperative projects carried out by the IBWC originate in different ways. On the one hand, the IBWC is required to implement provisions found in existing treaties. Yet, the specifics of any joint IBWC initiative necessitates negotiation over the details of an operational agreement. These agreements take the form of "Minutes" that are signed by each Commissioner. Once the "minutes" are approved by each country, they become normatively binding on the two governments (Gavrell, 2005).

Recently, attention surrounding the IBWC focused around negotiations to settle the "Rio Grande Water Debt". Inasmuch as "drought" is poorly defined in the treaty, the results of sustained drop in rainfall were quickly felt in water delivery to the USA By June 2002, Mexico "owed" the USA a full 2 billion m^3 of water that the treaty compelled them to deliver via the river, but which they had not. To understand the magnitude of the deficit, these 480 billion gallons of water are enough to provide Los Angeles with all its water needs for 2 years. Accordingly, in 2002, the IBWC Commissioners signed Minute Number 308 which offered a partial solution to the Mexican water debt (Mumme, 2005). Beyond discussion of water quantities, the agreement commits both parties to increased investment in water conservation of the Rio Grande drainage basin and recognizes the need for additional institutional reforms (including a binational conference) to strengthen the sustainable management of Rio Grande waters.

In retrospect, the Mexican/US experience along the Rio Grande offers an example of an institutional solution to water scarcity and joint management of a common hydrological resource. Most of the management problems that arose for over a century were resolved peacefully, through a fundamentally apolitical binational body. The fact that the treaty does not limit itself to "supply" but imposes expectations for water conservation on both sides is also significant. On the other hand, there is much to be learned from the deficiencies of the Rio Grande dynamics. Hydrologically, any strategy for managing groundwater is conspicuously lacking and there is no real attempt to address the "ecological" needs of the river basin. The treaty also has not been sufficiently dynamic. Since 1944, the hydro-political reality has changed and Mexico is left disadvantaged, despite its weaker economic status. Ultimately, compliance with the agreement has not been as impressive as those existing between the USA and Canada.

Many of these critiques can be levied against the present water agreements to which Israel is a party with its neighbors. The fact that drought conditions are likely to become exacerbated under most climate-change scenarios suggests that water treaties must be more specific about finding equitable solutions to adjust to the ineluctable cycle of wet and dry years. Moreover, the professional nature of the Commissioners and their mandate to take proactive initiatives stands in context to the present framework set forth between Israel and its neighbors.

5. Conclusion

Given the fact that Israel's water agreements are part of far broader peace agreements intended to resolve all aspects of a protracted and complex conflict between historic adversaries, the provisions they contain that focus on resolution of water disputes are impressive. The institutions established to coordinate water management are certainly comparable in size and composition to successful, preexisting models. While they do not enjoy some of the flexibility and independence of other JWC, given the sensitivity of the overall political climate, this is surely understandable and is something that could change in subsequent agreements. The fact that there are good agreements that can literally be taken back off the shelf, without the need for the tiresome rituals of negotiations is encouraging.

In the first round of negotiations, water quantity allocation dominated the agenda, which may have made it easier to "slip in" many of the excellent environmental provisions. However, this is also reflected in the lack of a meaningful implementation programs and the general disappointment with compliance on both sides with many of the water quality-related commitments. Nonetheless, even conscientious environmental officials would have had a hard time overcoming the general context of enmity and renewed violence that has characterized so much of the local experience in the new millennia since the agreements went into effect. Moreover, the great gaps in economic capability and existing environmental infrastructure between Israel and its neighbors have only grown worse during the past several years. This asymmetry could potentially become a serious obstacle to progress once the countries return to an "implementation" mode and the present hostilities (and consequent environmental coexistence stalemate) subside. Yet it could surely also offer an opportunity for external economic support to Israel's Arab neighbors, as the donor community seeks to find constructive ways to contribute to a lasting peace arrangement.

There are several areas, however, where Israeli, Jordanian, and Palestinians negotiators in the next round, who consider a final resolution might gain valuable insights from the world and other transboundary water agreements. Among these are greater engagement of the public, and mechanisms for involving them in a framework for comprehensive hydrological planning that should be done together to preserve water quality and ensure water supply. The objectives of this planning framework (and a deadline for completion) need to be clearly defined in a new agreement. The private sector might also be mobilized through the next round of agreements, either as subcontractors or as primary actors in a regional water market that is the subject of so many academic proposals (Fischer, 2004).

Looking to the future, it is likely that the success of desalination will lead to a diffusion in the tensions surrounding water-quantity issues (Kroneneberg, 2004). As the price for "manufactured" water continues to drop, and availability increases, water quality issues, including supplying wet, ecological habitats will grow significantly. Aquatic habitats, restoration of streams, and reviving the Dead Sea can suddenly be a salient topic, even in arid regions, should the political will exist. Today the technology is in place. Not just ecology but economics should figure in future agreements. Water-supply provisions should be joined by joint demand-management strategies, as is found in other treaties, to ensure that a resolution of the water disputes is not just reasonably equitable, but also reasonably efficient. The success of past water agreements around the world for creating shared frameworks for watershed management, and a growing consensus about just what the substance of "international water law" is, offer hope that the present conflict between Israel and its neighbors will be resolved through negotiations and yet another chapter in the evolving history of transboundary water agreements.

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ENGENDERING WATER IN THE MIDDLE EAST: SOME PRELIMINARY THOUGHTS

EVA M. RATHGEBER[1*] AND PNINA MOTZAFI-HALLER[2]
[1]*University of Ottawa*
[2]*Ben Gurion University*

Abstract: In this paper we present some preliminary thoughts on the importance of gender as a meaningful category in the politics of water in general and in the Middle East, in particular. There is very little research on the gendered use of water in the Middle East. Our main purpose is to introduce professionals in the field of environmental and water sciences to the importance of a gendered analysis in policymaking. We provide first an overview of the way that gender has been integrated into development planning and of the key concepts and debates involving theory and practice. We then present a more focused analysis of the links between gender and water.

Keywords: gender; water politics; Middle East; women in development; gender and development; critical theory

1. Introduction

Access to and availability of water is one of the most crucial issues in the Middle East. The Middle East North Africa (MENA) region has approximately 5% of the world's population, but less than 1% of available global freshwater resources, making it the most water-scarce region in the world. Over the past decades, water scarcity in the region has become a highly contentious subject of international disputes engaging politicians, scientists, and policy makers. Such discourse has tended to focus on legal ownership, national security, environmental degradation, and water scarcity, but it has seldom addressed the specific needs of different categories of users. In this paper we present some preliminary thoughts on the importance of gender as a meaningful category in the politics of water.

*To whom correspondence should be addressed: 143 Seraphin-Marion Ottawa, ON K1N 6N5 Canada, E-mail: RPR@sympatico.ca

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This paper is based on a presentation made to an audience of environmental scientists at a conference on integrated water resources management and security in the Middle East held at the Arava Institute for Environmental Studies in Israel in February 2006. As such, our emphasis here is primarily to outline some basic concepts related to gender and water management. Our main purpose was to introduce this particular body of professionals in the field of environmental and water sciences to the importance of a gendered analysis in policymaking. We thus keep to the minimum the more detailed theoretical debates and issues familiar to gender studies specialists. This analytical focus also means that we stay at the general level of linking gender and water management and pay less focused attention to the specificity of the Middle East region. A preliminary, review of the literature has shown that there is very little research on the gendered use of water in the Middle East. For the most part, water issues have been treated from a technical (e.g. environmental, legal, engineering) perspective rather than from a social perspective. Given the paucity of research on gender and water in the Middle East, our linkage of water management and use to its social environment is critical and should be followed up by further research. In the following sections we provide first an overview of the way that gender has been integrated into development planning and of the key concepts and debates involving theory and practice. We then present a more focused analysis of the links between gender and water.

2. Gender and Development: Understanding the Contradictions

We begin with some key questions: Why is gender or a "gender perspective" necessary for development planning in general and for water management policies in particular? What is a "gender perspective"? When was it introduced into development discourse and practice, and how has the idea of linking gender with development thinking changed over the years? Finally, how are contemporary ideas about gendered development relevant to practitioners dealing with water management policies? The following discussion provides some answers to these key questions and it is useful to begin with the declaration of a few basic assumptions that underlie the notion of a gendered perspective in development.

The first is that gender is about the relationships between men and women in society (and not exclusively about "women"). These relationships are socially constructed and are not an outcome of fixed biological differences between the sexes. The second is that relationships between the sexes are often unequal (i.e. the overriding social structure tends to be patriarchal). The third proposal stems from the first two and argues that if gender inequality, like any other kind of social inequality is constructed and not "natural", then the structural factors that shape and perpetuate it can be deconstructed and altered. In other words, to achieve gender equity one needs to make an effort to reshape society. The fourth key assumption is that *not* addressing gender-based inequalities is not a "neutral" position, but an act that contributes to the reproduction and perpetuation of the material conditions and the cultural legitimization of existing structures of inequality.

When brought into the development arena, a gendered perspective presents a real challenge on many levels. It proposes that *any kind* of development intervention is *by definition* a gendered social practice. Most critically, such a perspective says that access to all resources (including water) is always gendered and therefore all projects and policies reinforce or challenge accepted patterns of gender access to resources, i.e. gender inequality. However, the idea that gender is a critical category that must be considered in development planning and practice is still not widely accepted in development institutions. We turn now to a brief review of the way the gendered perspective has entered development work.

3. The Women in Development (WID) Perspective

Until the early 1970s, development work was carried out in a gender-blind framework. Development was seen as an overall effort to improve the standard of living in developing countries. If the household became better off, it was assumed that men, women, and children would all benefit equally. This gender-blind model of economic development was challenged during the 1970s by research that began to demonstrate that the interests of men and women (even if they are in the same household) are often different and at times contradictory. Danish economist Esther Boserup's, *Women's Role in Economic Development* (1970) was particularly influential in establishing a critique of the dominant modernist perspective. Boserup showed that women played a critical role as producers in agricultural systems but that their contribution was bypassed systematically by project planners. Later, scholars demonstrated that in many male-defined and male-dominated development projects, women's position and their economic opportunities worsened rather than improved.

A new sub-field of development thinking and practice known as Women in Development (WID) emerged from this thinking. The rational for WID was essentially modernist. It justified the need to include women in development work on the basis of economic rationality rather than on abstract moral grounds. The modernist logic was that the inclusion of women in projects would yield better economic results. According to such modernist logic, once the important contribution made by women to agricultural production systems or to the household economy in urban settings was made "visible", donors would realize the inherent benefits of including women in such projects and would thus "mainstream" women into planned projects. By the mid-1980s, "women's issues" were becoming increasingly relevant to many development agencies and the Third UN Conference on Women in Kenya in 1985, which produced the *The Nairobi Forward-looking Strategies for the Advancement of Women*, contributed to this trend by articulating specific guidelines for governments and donors to ensure the greater participation of women and women's interests in their programmes. Consequently, by the late 1980s, many donor agencies in North America, the Netherlands, and the Scandinavian countries had placed women on their development agenda.

However, by the late 1980s and increasingly in the early 1990s, the WID liberal-efficiency approach was coming under attack by critical thinkers. Before discussing the nature of this critique, it is necessary to stress here that the critique of the WID approach did not detract from the power of the perspective and it continues to this day to be the primary approach used to insert women and women's interests into mainstream development work. A good example for the continued tenacity of the WID approach is the 1996 World Bank publication entitled *Toolkit on Gender in Agriculture*. The toolkit was designed for World Bank staff "who are grappling with the day to day issues of gender-sensitive programming". The goal of this "ready-to-use material" was to convince World Bank staff that "incorporating gender perspectives into their work" would "improve project performance." The argument is simple and worth reproducing here because it epitomizes the economic efficiency logic that underlines the WID approach and the fact that it continues to be necessary to repeat and make accessible this logic to practitioners almost 20 years after its first appearence:

> Women play a critical role in agriculture in the developing world…Recent decades have witnessed substantial gains in agricultural productivity…these advances often by-passed women farmers and reduced their productivity. Women are thus underperformers in agricultural production…[thus] Countries must find ways to overcome this productivity gap in order to meet the challenges of food production… .

This practical "how-to" manual warns practitioners "ignoring gender concerns can lead to project failure" (ibid). The manual urges project planners to consider the differences between men's and women's activities and access to resources in order to identify the possible constraints and opportunities placed on each sex. Gender analysis means "seeing what our eyes have been trained not to see" (ibid). The manual supports such statements with specific examples. In a monitoring work on cotton projects implemented in three francophone African countries, the writers note, project goals were achieved in strict economic terms. However, while the male farmers benefited from the project, women and children were adversely affected because the project increased the power of male household heads in addition to the amount of labour demanded from women and children. Project planners are thus urged to begin each project by ascertaining the existing gender division of labour; who uses what area of land and for what purpose; who owns land and/or livestock; who has access to water or any other resource in the community; and how will such relative access to resources be impacted by the planned project? Gender analysis according to this logic is necessary *before* a project is designed.

The efficiency argument has been justified on several grounds. It is cost-effective to invest in women and construct women-centered projects because women are mothers and the key managers of their family's nutrition. Thus, by integrating women into projects designed to increase food production, family nutrition will improve. Another track of this efficiency approach pointed to the well-documented fact that women are the main water and firewood providers in their households and are key environmental managers. Inserting women into projects that aim to improve environmental responsibility is thus an efficient strategy. Finally, a third variant of the efficiency approach points to studies that have shown that investment in women's education brings the highest yield in the long run.

4. Alternative Approaches to Gender and Development

The liberal market ideology and the focus on efficiency was the dominant approach in the development field throughout the 1970s and 1980s, and the integration of women into projects was seen as simply another component of "good" development management. By the late 1980s, the WID approach was being criticized for its narrow economic logic. Some scholars argued that development institutions had accepted the basically conservative idea of gender equality and that the WID approach never challenged or even questioned basic societal structures in local settings. Donor agencies were never really committed to facilitating the needed changes in existing patterns of gender inequality and preferred to regard these local patterns as "cultural" and therefore outside their domain. The reluctance to influence what was seen as local cultural constraints to development partly can be explained by the dominance of male staff in development agencies. Many senior staff did not see gender inequality in the societies where they worked as being fundamentally problematic.

In the late 1980s, a new approach, Gender and Development (GAD), which identified structural gender inequalities as a core issue, began to emerge. Gender and Development proponents called for a re-examination of the social context that defined women's position in society – in education, legal status, technology, and health. Unlike the WID approach that promoted policies and projects aimed at enhancing women's economic position as the main goal, the GAD perspective argued for projects that addressed gender power relations with the intention of transforming power imbalances. The emphasis of GAD-inspired development work was to develop projects that would bring about significant social change rather than only economic enhancement. The GAD framework placed equity at its core thus expanding the analysis to include other forms of inequity that affect women's lives, including class, race, and ethnicity. The position of women in each society, according to GAD, is the result of multiple power relationships and therefore one cannot assume a single coherent voice that represents the interests of all women.

Nonetheless, the most profound criticism of the WID perspective came not from the proponents of the GAD approach, but from a small group of mostly Southern critical scholars who questioned the centrality of the North in the development arena. The perspective articulated by such critics came to be known as Development Alternatives with Women for a New Era (DAWN). They argued that the logic at the centre of the WID perspective posits women in the South as backward, vulnerable "others" in need of salvation by donor institutions from the North. These critical scholars and activists argued that women in the South do not constitute a uniform category of "Third World Women" and should not be seen as hapless victims but as partners and agents in development projects. Unwittingly, the uniform representation of a hapless victimized "Third World Woman" served to justify neocolonial domination of the North. Southern critics argued that the WID perspective represents Western male-centered thinking that never challenged patriarchal assumptions. DAWN calls for the creation of a real dialogue between donors and their "clients", where women are not merely recipients of development assistance but active players in shaping development goals.

It is important to note that the diverging views reviewed above did not replace each other and that within development agencies that are often conservative and largely bureaucratic bodies there continue to be voices that represent all three perspectives. While many donor agency staff still need to be convinced that gender is a critical issue in their work and for them a simplified WID argument is necessary and effective, others might benefit from the more nuanced understanding brought by the GAD and DAWN perspectives[1].

[1]The literature that deals with the history of gender and development work is vast and we have not made reference in the body of this brief introductory section to this work. Interested readers might want to turn to the excellent volume edited by Marianne Marchand and Jane Parpart *Feminism/Postmodernism/Development* (1995), to Catherine Scott's book *Gender and Development: Rethinking Modernization and Dependency Theory* (1996) and to the special issue of

5. Gender and Water Management

The first section of this paper has outlined some basic gender concepts and explained why gender analysis should be a central component of all development activities. In this section, we focus specifically on the water sector, illustrating the need for the incorporation of gender into water decision-making at the micro, meso, and macro levels. In the MENA region, the combination of scarce water resources, rapidly growing population, and irrigation development are causing severe water shortages, but interestingly, although water is a core development issue, there are almost no documented case studies of the gendered nature of water-resource management in MENA. There may be many different reasons for this, including the fact that small-scale farming in the region is usually undertaken as part of a family enterprise so that the different water needs of men and women have been subsumed under the more generic category of "family" needs. Moreover, in a region that faces severe water shortage, there may have been a tendency to regard gender analysis in the water sector as a "luxury" that does not have significant importance in comparison to other more immediate and pressing concerns. However, the reality is that the power relations within the family, which have been discussed above, while not necessarily adversarial, usually dictate the way that priorities are set. This is as true for questions of water allocation and use as for other issues. Below we provide some illustrations.

Although there is little existing research on the different water needs of male and female farmers, a 1998 study in Egypt, undertaken by the Ministry of Public Works and Water Resources, focussed on the knowledge, attitude, and practices of Egyptian farmers towards water management (El-Zanaty and Associates, 1998). The survey of more than 2,000 farmers included almost 200 female farmers, most of them widowed and heads of smaller households. The majority of the female farmers had never attended school and had little knowledge of water issues. This is significant given that one finding of the study was that the better-educated farmers said they were more willing to contribute to the cost of water system improvements. The study also found that women farmers were less willing to join Water Users Associations because of the preponderance of male members. Finally, the study revealed that about 43% of the male farmers said that their wives were active participants in agricultural and irrigation work on the family farm, and the researchers observed that the wives

Signs: Journal of Women in Culture and Society of 2003 (vol 29, 2) titled *Development Cultures: New Strategies, New Realities, New Environments. For a further explanation of the origins of the WID and GAD perspectives, see Eva Rathgeber, "WID, WAD, GAD: From Theory to Practice,"* ***Journal of Developing Areas*** *24 (1990): 459–502.*

tended to have a good understanding of farm water problems, suggesting that there was communication between husbands and wives. While this information pertains to only one country in the MENA region, it begins to unpack the notion of the "farm family" by identifying a few important gender-based differences.

Researchers in the Middle East and elsewhere are developing methodologies, frameworks, toolkits, and indicators to understand the multiple uses and values of water in developing countries. A few analysts place gender at the centre of their framework. Others put economics or environment at the center. However, if gender is not included in the analysis, then it is highly probable that women's water needs, whether for domestic, agricultural, or entrepreneurial purposes, will be overlooked. Below we discuss a few of the different water requirements of men and women, which to a considerable extent are based on their socially assigned tasks and roles.

6. Competing Needs

The water needs of men and women, especially in rural areas, vary in many respects and under conditions of water scarcity, these needs sometimes become competitive. At one level, all human beings require water for drinking and for personal hygiene, however in most societies where water is not instantly and conveniently available, the responsibility for satisfying the water needs of the household falls to women and girls. Thus, access to water for domestic purposes is a priority for them. Men's responsibilities often focus on income generation, including farming and herding. Thus, water for agricultural or livestock purposes is a priority for them. This simplistic dichotomy overlooks the substantial contribution that women make to agriculture and to livestock production, but it serves to illustrate the immediacy of conflicting interests, based on gender roles.

In some societies, faced by severe water shortages, provision of water for household needs is an onerous responsibility. For example, the Gender and Water Alliance estimates that in Africa, 40 billion person hours per year are spent in collecting water, mostly by women and girls (http://www.genderandwater.org). Conflict can arise when decisions have to be made about how scarce resources will be used or in cases where water for domestic purposes has to be purchased. In both instances, because of their status in the family, women are likely to have less decision-making power.

7. Choices by Policymakers

A realistic appraisal of women's work, which includes both recognition of their contribution to agriculture and their role in informal sector production activities, would understand that women's need for water is situated not only within the domestic sphere but also equally within the economically productive sphere. Unfortunately, however, water policymakers often make decisions based on the first, simplistic dichotomy rather than on a more in-depth and nuanced analysis, and consequently although women use water both for productive and domestic purposes, their productive water needs are rarely factored into water decision-making. Many water resources planners hold traditional views about women's use of water and assume that their needs lie primarily in the fulfillment of household tasks. In reality, the time that women lose in walking long distances to fetch water, detracts from their overall productivity and efficiency. Consequently, "access" to water should be seen in the context of women's productive activities including use of time and energy spent in fetching water.

8. Access to water

Access to water for the rural poor is greatly influenced by environmental degradation. Deforestation and contamination of water sources increases the time women spend seeking fuel wood or safe, clean water, and increases the risk of contracting a water-borne disease. Soil erosion, water shortages, and crop failures reduce harvest yields; soil exhausted from overuse reduces the productivity of household gardens. All of this has important time implications.

For example, in resource-poor mountainous regions in Yemen, women and girls prepare animal dung for fuel, fetch fuel wood and water, and handle all domestic work – including childcare. In addition, they contribute about 31% of the labour supply for crop production and terrace repair. Groups of women travel long distances carrying collected fodder, wood, and water over steep slopes and because considerable time is spent in looking for and carrying water, their labour is diverted from other agriculture-related tasks (Aw-Hassan et al., 2001). Similarly, in some parts of Africa, women and children spend up to 8 h collecting water, and some estimates suggest that the average distance walked daily by women in search of water is six km (Rathgeber, 2003).

In the MENA region, water shortages are common both in rural and urban areas. Roudi-Fahimi et al. (2002) note that MENA's growing population, together with increasing per capita income, greater urbanization, and greater access to running water, has increased the demand for fresh water for domestic use. Inevitably, this sometimes leads to conflicts of interests.

9. Agriculture

Irrigation is the biggest user of the world's water but many systems are inefficient, losing substantial quantities of water due to evaporation or return flow to rivers and groundwater aquifers. Both male and female farmers often use water inefficiently. For example, the 1998 survey of Egyptian farmers carried out by the Ministry of Public Works and Water Resources (MPWWR) found that many farmers did not have a good understanding of irrigation processes (El-Zanaty and Associates, 1998). In the MENA region, agriculture accounts for the vast majority of freshwater use, although by 2001 only 41% of the population lived in the rural areas (Roudi-Fahimi et al., 2002).

Water use in irrigation is a contentious issue because there continues to be debate about the overall impact of irrigation, especially from a gender perspective. Benefits of irrigation include:Increased crop outputs, possible diversification into and/or introduction of higher value crops, utilization of technologies aimed at increasing yield, and provision of employment for landless poor. But there is no consensus that irrigation alleviates poverty, especially not for women. In fact, women are often disadvantaged because irrigation agencies define who will use irrigation water and their Criteria may include: land ownership, not land use; men only; heads of households; or both men and women. They may be insensitive to or unaware of the different rights of men and women with respect to natural resources, including land and water. This creates a strong possibility that the poorest members of the community will be at a disadvantage. In many developing regions, female farmers are especially active in rainfed areas. Agricultural workloads tend to be heavier in non-irrigated areas, due to generally poorer economic standards.

10. Cultural practices

At the community level, water management is greatly influenced by prevailing cultural practices. Because there has been little gender analysis of water-resource management in the MENA region, it is useful to draw on experiences from elsewhere to illustrate this point. In Africa, as in South Asia, water collection is usually undertaken by women and children, but Njong and Kanaroglu (2001) found in a study of a village in northeastern Nigeria that men also participated actively in water collection activities in communities where women were secluded The community's most important factor for the choice of water was proximity to the village, but people would not use water that was situated within the domain of another ethnic group. Moreover, Hausa women, who were Muslim, were secluded and forbidden to draw water from public sources where they risked being seen by males unrelated to them. Finally, the researchers found that in periods of drought, the water used for cleanliness and hygiene was eliminated and consequently there was a higher incidence of diarrhea during dry seasons. Moreover, despite the water shortages in the community, most people did not actively practice conservation because they had never been taught to do so. This is consistent with the Egyptian study that found that farmers had little knowledge about how to use irrigation water most efficiently (El-Zanaty and Associates, 1998).

11. Health

According to the World Health Organization (WHO), at any given time, one-half of all people in developing countries are suffering from one or more diseases associated with water supply and sanitation (Rathgeber, 2003). These include diarrhea, trachoma, schistosomiasis, and malaria among others. Although everyone is affected, women are more frequently in contact with polluted water. For example, 70% of the world's blind are women who suffer from trachoma, which is contracted through infected water sources. Similarly, studies in Egypt have shown that both men and women suffer from schistosomiasis as a result of exposure to polluted water in canal irrigation, but women often have greater exposure because they use canal water not only for agriculture but also for other household duties, such as washing dishes or laundry (Watts and El-Katsha, 1997). In Africa, although greater numbers of women are affected with HIV-AIDS, mostly women look after sick family members. Time and attention required by AIDS patients places heavy burdens on women, (often mothers, grandmothers, or aunts) and the household need for water increases while labour for fetching water often decreases. The burden of disease in developing countries and the expectation that women will be the front-line caregivers to sick family members is not an issue that is taken into account by water resource planners. Lack of easy access to clean water can have a very severe impact at the household level in terms of the level of care that can be given to the ill.

12. Privatization of Water

Since the 1990s, the World Bank has heavily promoted the privatization of water. Although the intention has been to remove the full burden of water provision from the cash-strapped public sectors of most developing countries, the experience has been mixed at best. In many countries, privatization has led to lack of access, especially for the urban poor. There have also been price increases, water disconnections because of unpaid bills, lack of accountability, deterioration in water quality, and threats to hygiene. There continues to be a debate about the level of responsibility of governments to provide at least minimal safe drinking water for all citizens. Interestingly, research in Uganda suggests that women, especially educated women with formal sector jobs, place greater importance on paying water bills compared to men (Kayaga et al., 2003), which is not surprising in light of our earlier observation that they have major responsibility for the provision of water for the entire family's domestic purposes.

The issues discussed above provide a preliminary overview of the gendered nature of water resource management. It is evident that although the needs of men and women are not necessarily adversarial, they do differ based on the social roles that each sex has been assigned. Even working within the WID framework and not questioning the assumptions implicit in these roles, it would seem both logical and efficient for water resource managers to try to ensure that there is a fair balance between the conflicting water needs for agriculture, industry (small scale or other), and domestic purposes. Indeed, in recent years, many international agencies have put emphasis on Integrated Water Resource Management (IWRM), an approach that considers all of the different water needs. The IWRM approach considers the affects of each type of water use on the others, and takes into account overall social and economic goals, including the achievement of sustainable development.

For specialists working in gender and development, the points made in this paper about the importance of looking separately at the situations of women and men in terms of access to resources, sexual division of labour, decision-making opportunities, etc. are self-evident. However, not only water development practitioners but even researchers working on sustainable use of water frequently neglect to introduce a gender perspective into their work. Within the worldwide Consultative Group on International Agricultural Research (CGIAR) system, a small number of mostly social scientists, has done important research that demonstrates the value of looking separately at the water needs and the water access experiences of women and men. The work of CGIAR scientists like Barbara van Koppen, Margaret Zwarteveen, and Ruth Meinzen-Dick is especially relevant in that it presents carefully accumulated evidence of the gendered nature of water management and use, and the dangers of overlooking this evidence. However despite the painstaking research done by these and other scientists, the CGIAR system still does not include gender analysis in all of its work. For example, a book of five background papers for the CGIAR Water Challenge Program, which was launched in 2003, reflects on technological and institutional challenges to improving crop water productivity and sustainable water resources management, but there is no consideration of gender (CGIAR, 2003).

13. Improving the Participation of Women in Water Management

In closing, it is worth briefly examining the role of women in water management. In fact, women are conspicuously absent in water-resource management in many parts of the world. While it is not argued here that the simple infusion of greater numbers of women into water management will necessarily lead to a more gender sensitive approach to water resource decision-making, it is unlikely that gender sensitivity will occur without the participation of more female professionals.

13.1. POLICYMAKERS

Because of their seminal role in water decision-making, it is evident that efforts to bring more women into water resource management should begin with the sensitization of policymakers. Ideally, mid-level policymakers should be targeted for intensive gender analysis training and senior level policymakers should receive short introductions to main concepts and tools of gender analysis. Once having had such training, it is more likely that policymakers will try to integrate gender into national water-resources policies. There is often little capacity within Ministries of Agriculture, Natural Resources, or Fisheries to implement or even fully understand the implications of gender policies, therefore implementation guides should be established, together with clear targets and accountability criteria.

13.2. TRAINING FOR FEMALE PROFESSIONALS

Concerted efforts must be made by educators at all levels to encourage girls and young women to consider careers in water resource management. Efforts should also be made to encourage the participation of female professionals in the design of conceptual frameworks for irrigation schemes, settlement schemes, or land reclamation activities, and in water conservation and harvesting research.

In South Africa, Lesotho, and Uganda affirmative action has led to training of women for water and sanitation careers. At the local level, women have been trained to locate water sources in villages, decide on the location of water services, and undertake simple pump repairs. In each case, these activities were promoted when the countries in question had female Ministers of Water Resources. Overall, the number of women in such positions is still small; in the mid-2005, there were about 40 female ministers of water or environment, representing every region of the world.

14. Conclusion

The Middle East, more than any other part of the world is facing increasing water shortages. In this context there is a grave danger that the water needs of the less vocal, less empowered, be they women or the poor, will continue to have a very low priority. The consequences of this will be harmful for everyone. For this reason, if for no other, it is necessary for national governments and donor agencies to ensure that water development planning becomes gender-sensitive.

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WATER, AGRICULTURE AND ZIONISM: EXPLORING THE INTERFACE BETWEEN POLICY AND IDEOLOGY

CLIVE LIPCHIN *
Arava Institute for Environmental Studies, Israel

...water is not merely an economic resource but a means of settling the periphery, protecting state land and a means of conserving farmers and farming.

Ariel Sharon, Israel's Prime Minister, *Ha'aretz Daily Newspaper*, April 19, 2001

Abstract: Israeli agricultural and water policy over the last 50 years has been heavily influenced by Zionist ideology. The central aim of Zionism and of the State of Israel is the creation and nurturing of a Jewish presence within the geographical context of Israel/Palestine. In achieving this aim, Zionist and Israeli leaders have striven to increase of the Jewish population through promoting immigration and pro-natality polices, establishing a cooperative and rural mode of life by laying claim to the land and securing peripheral areas through territorial settlement.

Territorial settlement of the land by means of agriculture was considered a national goal for a continued Jewish presence in Israel. This policy might have had relevance during the establishment of the State but today has left a legacy of mismanagement and environmental degradation. Agricultural settlements meant to help disperse the population to peripheral areas provided an economic foundation for the country based on rurality and cooperativeness that served to bond the Jew to his homeland. From this ideological perspective, policies were instituted that favored the expansion of agriculture and by extension, water development for irrigation projects.

All water resources within the country became the property of the State and a highly centralized system of water management, allocation, and development was implemented. Nevertheless, throughout the history of the State, agriculture has never fulfilled its ideological objectives. Today, crisis, conflict and acute water scarcity loom large in the region.

*To whom correspondence should be addressed: Clive Lipchin, PhD, Arava Institute for Environmental Studies, D.N. Hevel Eilot 88840, ISRAEL. Tel: 972 528 964992, Fax: 972 8 6356634, E-mail: clive@arava.org

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In this paper, I discuss the evolution and persistence of Zionist ideology in Israeli agricultural and water policy. The paper argues for a revision of Zionist thought that is necessary for sustainable management of existing water resources. Data were collected, by means of a survey questionnaire, on local perceptions of the importance of Zionist ideology with respect to water and agriculture. These data were gathered from a representative sample of residents from ten kibbutz settlements in the southern Arava Valley. The data provides a link between local and national perceptions. Results indicate that people still believe Zionist values pertaining to water and agriculture at national, regional, and local levels despite the concomitant ecological risks and minimal economic return. Changing these perceptions will require not only political courage but local attitudinal changes as well.

Keywords: water management; Zionist ideology

1. Introduction

In a country with naturally scarce water resources, it is astonishing to see that Israel's water policy does not reflect this natural condition. To fully understand Israel's water crisis, one must refer to the ideological forces which shaped and continue to shape the country.

Israel's water resources consist of surface and groundwater. Groundwater is rapidly becoming the primary source of water as demand grows and surface waters diminish. The Sea of Galilee in the north is the country's only large surface water reservoir. Two aquifer systems are also utilized: the coastal aquifer, stretching from Haifa in the north to the Gaza Strip and the Sinai Peninsula in the south, and the mountain aquifer that straddles the central mountainous plateau. All of these water resources are in decline as demand grows.

Signs of distress are also evident. Regions of the coastal aquifer are heavily salinized because of overpumping, thus causing wells to be closed. In the mountain aquifer system, water quality is severely degraded due to pollution from agricultural, industrial, and commercial use. Overpumping from all three resources has caused water levels to steadily decline over the last decade (Gabbay, 2000). Exacerbating the problem is the political dimension in which all of these resources exist. Israel's water resources are transboundary. Jordan and Syria are riparians to the Sea of Galilee and the Palestinian Authority is a riparian to the coastal and mountain aquifers. As water resources diminish and political tensions continue to rise, the specter of war over water hangs large over the region (Lowi, 1993).

In order to fully understand the decline in water resources in the country, we must examine the role ideology played in the development of water resources. Ideologies, which can be manifested as religion or belief, are strong proximate causes for the development of water resources in arid regions. For example, in the Southwestern USA, the Protestant pioneer spirit of man's dominion over nature has led to large-scale irrigated agriculture and massive public works projects for the exploitation of water (Gleick, 1994). Throughout the Middle East, water users, water-providing institutions, political leaders and politicians concerned with the water sector have been overly confident in meeting water demand with limited water supplies. These perceptions have lead to the building of large public water works projects. Nevertheless, such perceptions are not unique to the Middle East.

In Israel's case, Zionism played a fundamental role in the development and management of the country's water resources. Data gathered from residents of ten kibbutz settlements show that water-related Zionist values continue to persist at not only the national level, but at the local level as well. These value systems have discounted natural scarcity and have contributed to the water crisis in the country. Unless a revision of Zionist thought, as it pertains to agriculture and water, is undertaken by decision-makers and the public, it will be extremely difficult to replace current management practices with ones that are more sustainable.

2. Water as Ideology

The construction of the Jewish State in Palestine was executed under the umbrella of Zionist ideology (Hillel, 1994). A strong link exists between socio-political ideologies and the spatial organization of the country. Ideologically, emphasis has always been placed on rural or agricultural settlements over urban centers. The country has maintained this orientation despite the fact that most of the population has preferred to settle in big cities and towns and to pursue nonagricultural professions, primarily those of services and technology. The Israeli government maintains a strong involvement in the economic activity of the country and in terms of agriculture, this intervention is executed through the country's water policies.

The State of Israel operating under a Zionist paradigm has pursued three objectives that are central to the achievement of a Jewish homeland in the biblical land of Israel. These are population growth, mode of life and territory (Frederick, 1996). The government promoted pro-immigration and pro-natality policies in order to create a Jewish majority in the country. This policy is best represented by the "Law of Return", which grants any Jew that seeks it, automatic Israeli citizenship should he or she choose to settle in Israel. The second and third objectives are particularly relevant to agricultural and water development. An ideology has developed around water by virtue of its association with agriculture. Zionism sought to restore to the Jews of the diaspora which they lacked: land. Agricultural activity was central to the achievement of this goal. By working the land, Jews would be returning to the Promised Land of Israel in the most literal sense (Lipchin, 1997). Working the land included a territorial component in that one who works the land also has rights of ownership to it. Within this religious ideological framework, agricultural activity was considered as "redemption of the land" prior to the establishment of the State and as "the conquering of the unsettled" after the establishment of the State (Reisner, 1993).

From a political point of view, agricultural development was regarded as a means to the creation of a national territory for the Jewish people. Agricultural activity had important strategic military purposes in the establishment and defense of borders and peripheral areas with low population density. The ideological perception of agriculture as a means to settling the land had strong religious overtones as expressed in the Jewish harvest festivals and the concept of a jubilee year where the land is to lie fallow. This allowed for the nationalization of ninety percent of the country's land through legislation permitting the transfer of land and water resources to government auspices that was then leased to farmers or slated for development (Kellerman, 1993).

Agriculture was also considered to play a leading role in economic production and society, as expressed by collective ownership in kibbutz settlements or partial ownership in moshav settlements. During the period leading up to the State's establishment in 1948, most of the population agreed with the national emphasis on rurality and agricultural development, yet the rural population in pre-Israel Palestine never exceeded 29% (Kellerman, 1993) and today that population is no more than 4%. In 1931, 45.4% of the Jewish labor force in Palestine was employed in services and by 1987; it had risen to 65.5% (Lowi, 1993). That number continues to grow today due to Israel's rapidly expanding high-tech industry.

Early Zionist thought and Jewish settlement in the Yishuv (pre-state Israel) adopted a romantic ruralist approach to the environment (Reichman, 1975). The initial pioneers glorified the renewal of the relationship between the Jew and the soil after centuries of dispossession of land and life in the ghettoes of Europe. A part of this romanticism evolved from overt biblical connotations that lead to a value system of the land having strong biblical references (Kellerman, 1993). However, in actuality, the environment was harsh and unsuitable for human settlement. This led to anxiety among the pioneers who, for the most part, were anything but hardened farmers. The majority of the early pioneers were from urban centers in Eastern Europe unfamiliar with the harsh climatic conditions of an arid country. Romantic ruralism was thus rapidly replaced with an ethos of development whereby mastering the alien surroundings was a means of overcoming the anxiety of being faced with a foreign and unforgiving environment (Kellerman, 1993). Cooperative agricultural settlements were tools of the government policy to socialize new immigrants according to Zionist precepts. Water projects constructed for agriculture were thus guided by ideological and geopolitical considerations in which economic and environmental factors were of secondary significance. Available water resources were only considered of value if they could be harnessed and used for agricultural expansion. Economic pragmatism and climatic realities of low and unpredictable rainfall were brushed aside by the leading politicians of the day.

David Ben-Gurion, Israel's first prime minister, who has been forever linked in the mind of Israelis and Jews across the globe with the rallying cry: "make the desert bloom" was quoted as saying in 1953:

[*T*]*he water of the Jordan flows down to the Dead Sea, and the Yarkon water flows to the Mediterranean…even the rains, plentiful in the north and minimal in the south, flow wasted, in large measures to the Mediterranean or the Dead Sea, without fully benefiting the thirsty soil.* (Kellerman, 1993)

Consequently, throughout the history of the State, agricultural and water development have been favored by state policies. Despite the fact that agriculture and rural settlements have never fulfilled the territorial and demographic aims of Zionism this favoritism is seen in the unconfirmed borders of the State and the low population density in the periphery of the country. Rather, agriculture, and hence water development has remained in the socio-political realm serving ideological purposes, with little practical, economic, or environmental value in terms of its relation to the physical nature of an arid and water scarce environment. It can be argued therefore, that the current water crisis is not only one of diminishing natural resources due to increasing demand but also that of development of a resource in service of an ideology.

3. Israeli Water Development Projects

The ethos of development is best described in two significant public works projects of the 1950s and 1960s. The Hula swamps were a unique wetland system north of the Sea of Galilee that drained the tributaries of the Jordan River before they flowed into the lake. A public works project was conceived in the 1950s to claim the area of the Hula for agriculture and settlement. The draining of the swamps were meant to combat malaria, increase agricultural potential, utilize available peat as fertilizer and increase water potential by reducing evaporation losses (Zohary and Hambright, 1999). This was completed in 1958. However, the purposes for the project were never fully realized.

Malaria was brought under control prior to the draining in the late 1940s, but a market for peat never developed and in actual fact, the large-scale land subsidence that occurred resulted in the peat self-combusting. The low nutrient value of the soil made productive farming difficult and massive outbreaks of rodent populations destroyed crops. The draining of the swamps did allow for flood control of the Jordan's upper tributaries and the reduction of evaporation, but the environmental and economic costs of the project far outweighed the benefits. Water quality suffered from an increase in nitrates and sulfates, fish stocks declined, a loss of wetland habitat resulted in species extinctions and a major migratory bird pathway connecting Asia with Africa was disrupted. Most importantly, large-scale agriculture in the region was never realized. The Hula Valley Project did nonetheless stir the beginnings of the Israeli environmental movement with the founding of the Society for the Protection of Nature in Israel (SPNI). The SPNI successfully lobbied for a small portion of the swamps to be preserved in Israel's first national park (Tal, 2001).

The legacy of the country's ethos of harnessing water for agriculture is best described in the construction of the National Water Carrier in 1964. The expansion of agriculture into the arid south of the country required water for irrigation. The perception of plentiful water in the north was a justification for the creation of a centralized water delivery system to transport water to the dry south. Preparations for the creation of the Carrier were seen as a national priority for the survival of the State and for the establishment of a self-sufficient agricultural base. During this time, Israel bombed Syrian bulldozers that were diverting water from tributaries to the Sea of Galilee for their own water diversion project. Israel saw this act as a direct threat to its own water management plans considered to be inextricably linked to the continued existence of the State. Many have considered this act as a pretext to the 1967 Six Day War (Shlaim, 2000) (it is with historical irony that a repetition of these acts recently occurred with the diversion of the Wazzani River, a minor tributary source to the Jordan, to provide water for a series of villages in southern Lebanon. Israel clearly stated that it looks on this diversion as a serious provocation (Reuters, 2000)).

Prior to the 1990s, 80% of the water in the Carrier went to agriculture. Today, with demand rising in the municipal sector, half of the water is for municipal use (Tal, 2001). Like the Hula Valley Project, the environmental costs of the National Water Carrier continue to reverberate. Due to the massive pumping of the waters from the Sea of Galilee, the Jordan River downstream of the lake has literally ceased to flow as a natural river. Today the river is no more than a sewage conduit for untreated wastewater from Israeli and Palestinian urban and agricultural settlements. The Dead Sea that provides the terminus for the Jordan River has been shrinking at an alarming rate due to the lack of freshwater inputs from the Jordan. The unique ecosystem of the Dead Sea has been severely disrupted through fluctuations in water temperature and the influx of wastes as a result of declining freshwater input. The Sea of Galilee itself is shrinking. Since the above average rainfall of 1991/92, exposed areas of shoreline and piers ending meters from the water are a common sight. The redline set by hydrologists, below which no pumping should occur, has been continually shifted downward as drought conditions prevail and demand continues to rise.

4. The Rise and Dominance of Agriculture in Israeli Decision-Making

A reliable water supply is essential for the development of agricultural settlement. Government activity within the agricultural sector leaned heavily toward ensuring the success of agriculture despite limitations in water supply. The preeminence of agriculture within the socio-political realm influenced Israeli water policy and decision-making. Rather than developing within a market system, policy mechanisms for the management of water remained within the socio-political sphere dictated to by Zionist ideology and the importance of agricultural self-sufficiency. With the completion of the National Water Carrier ensuring water supplies to farmers in the south, the government instituted an extremely centralized water management regime that made water affordable to farmers through the implementation of subsidies. This allowed for the growing of a wide variety of crops, many unsuited to the arid environment. The true value of water thus became masked by a system of hydrological subsidies and aided by agricultural protectionism through import tariffs and trade barriers (JFK School of Government, 2001). Water-thirsty crops such as cotton, citrus, and flowers became profitable under these policies. Many of these crops are not only water-thirsty and poorly adapted to arid conditions, but they also require good quality water. Today, such farming practices are heading toward direct conflict with municipal consumers as demand for drinking water rises.

Such agricultural favoritism is not unique to Israel. Both Egypt and Saudi Arabia adopted wheat self-sufficiency policies in the mid-1980s (Allan, 2002). In the late 1990s, Egypt began expanding its agricultural production north and west of the Aswan High Dam (Wali, 1997).

The hold of agricultural interests over water within the government is clear. The Ministry of Agriculture is heavily invested in water allocations, distribution, and pricing. In 1959, the Israel Water Law was established, which effectively annulled private ownership of all water resources and placed their management with the state (Feitelson, 2001; Tal, 2001). Structurally, all water is managed by the national water company (Mekorot), also established in 1959. Mekorot is responsible in supplying water to all sectors according to the allocations set by a water commissioner. Prices are based primarily on quality and not on quantity. Under this scenario, brackish water is considered of little value even though it has great potential as a source of irrigation. Fresh water is also treated as having little value given the high rate of water subsidies to farmers (as much as 70% in some regions).

As long as such a system continues, weaning farmers off of water-thirsty crops will prove difficult. A corollary to this is the difficulty of instituting conservation measures across all water use sectors. This is especially significant as use is governed by quality and not the amount consumed. This is true not only in water-scarce environments such as Israel but also in water-abundant ones as well. The State of Michigan, lying wholly within the Great Lakes Basin of the USA and Canada and which constitutes almost 20% of the world's freshwater supply, has no policy mechanisms governing the amount of water used. As a result, many wells tapping aquifers in central and southeastern Michigan are running dry (Nicholas and Bluer, 2001).

Traditionally, the allocations set by the water commissioner and approved by the government ensure supplies to the urban sector but with guarantees to agriculture. The allocations rarely take into account sound hydrological and economic advice as is evidenced by the continued down shifting of the redline in the Sea of Galilee, below which, no pumping should occur.

In 1997, a committee charged with examining Israel's water management policies, the Arlosoroff Commission, recommended reducing water use in agriculture by valuing water according to pumpage costs, delivery, and distribution (Feitelson, 2001). The Commission also sought a change in institutional structure, pointing out the congruence of agricultural interests with the government appointed water commissioner and the Ministry of Agriculture as a barrier towards privatization of water operations and decentralization (Feitelson, 2001). The acting water commissioner and Minister of Agriculture summarily rejected the recommendations of the Commission. Even so, since 1996, the water commissioner has attempted to reduce allocations to the agricultural sector and to cut water subsidies to farmers. Since the 1960s, farmers have been allotted drinking water at a price 35% below that at which it is sold to households and industry (Cohen, 2001).

Israeli water policy is thus, in essence, a means of ensuring allocations to agriculture. Managing the water budget requires meeting allocations and avoiding discrepancies. Problems arise when discrepancies overcome allocations. There is little flexibility in the allocation system even when acute discrepancies occur. This is because allocations are not based on hydrological and climatological realities but rather on ideological grounds. These allocations function in meeting short-term demands. However, Israel's water budget can only meet short-term allocation goals by users if it overrides long-term concerns for the sustainability of available water resources (Dery and Salomon, 1997). The policy of making use of reservoirs as a buffer between lean and plentiful water supplies and for the long-term needs of future generations are ultimately discounted in favor of meeting present allocation targets, primarily those of agriculture.

5. The Decline of Agriculture

Today, a policy of water allocations based on ensuring ideological claims cannot meet the growing water crisis and is out of touch with the changing demographics of water users. Current realities reflect growing demands in the expanding domestic and industrial sectors. The country's population of approximately 6 million is expected to double in the next 27 years.

TABLE 1. Freshwater availability and demand in Israel in 1990 compared to selected other countries in the region and elsewhere (Libiszewski 1995)

Country	Yearly per capita freshwater availability (in cubic meters)	Yearly population growth and expected population doubling (at current rates)
Palestine (West Bank and Gaza)	100*	3.2% (22 yrs.)
Jordan	220*	3.4% (19 yrs.)
Israel	370*	2.6% (27 yrs.)
Lebanon	1,780	1.9% (34 yrs.)
Syria	2,830	3.5% (18 yrs.)
India	2,440	1.8% (35 yr.)
Switzerland	7,565	0.6% (116 yrs.)
USA	9,951	1.0% (70 yrs.)

*Under 500 m^3 is considered absolute water scarcity

Indeed, economically, there is little justification for continued agricultural favoritism. Agriculture's contribution to the country's gross domestic product (GDP) in 1991 was 3% and the agricultural labor force in 1990–1992 (as a share of total employment) was 4% (Libiszewski, 1995). Agricultural exports in 1990 were 2.5% (Libiszewski, 1995). There seems little justification for continued farming of water-thirsty crops such as flowers for export. Only 12% of the residents of agricultural communities actually earn a living from farming whereas the remaining 88%, that has nothing to do with agriculture, benefit from the use of subsidized water allocated to agriculture (Cohen, 2001). This discrepancy highlights the inefficiency of an allocation system that bases allocations on settlements and not on demographics.

The agricultural settlements of today are a far cry from what they were 50 years ago. Agricultural production is in decline whereas services and industry are on the rise. Nonetheless, because these sectors take place on settlements defined as agricultural, they enjoy the benefits of highly subsidized water.

Some agricultural settlements have reverted to wealthy bedroom communities that continue to benefit from subsidized water even when these communities can easily pay more for water. In addition, the current livelihood of many of these settlements does not reflect the Zionist ideal of rural farming communities. In fact, without government intervention, many of these settlements would have given up agriculture completely. Today the economic return of industry and tourism play a larger role than agriculture on many kibbutzim and moshavim.

The continued nepotism toward water for agriculture is accordingly out of touch with what is actually represented on the ground. Indeed, it can be argued that throughout the State's history, agriculture never should have commanded the largest slice of the allocation pie. At its height in 1941, the Jewish rural population engaged in farming was 29% and it has been declining ever since (Kellerman, 1993). In other words, the Zionist aim of establishing a large rural population engaged in agriculture has never been realized. Indeed, services and industry have always dominated Israel's economic landscape. Water allocations to these sectors where better management could perhaps take hold has not occurred, because they were never considered ideologically important, as was agriculture.

6. Zionism, Agriculture and Water in a Local Context

As discussed previously, ideological values have heavily influenced government decision-making when it comes to water allocations and a move from a centralized to a decentralized system should provide for greater local control and say in how water should be managed. But in order for more decentralized policies to take hold, ideological values that need to be reconsidered at a national level and at a local level.

As part of a larger study on people's perceptions and attitudes towards water use and scarcity, a set of close-questioned statements about the importance of agriculture, water and their related ideological values were posed to a representative sample of the kibbutz population in the southern Arava Valley (Lipchin, 2004) A total of 249 people all over the age of 18, were surveyed in 1999 (representing approximately 30% of the adult population).

The Southern Arava Desert is part of the Syrian-African Rift Valley. In Israel, the Arava Desert stretches from the Dead Sea in the north to the Gulf of Aqaba in the south. The use of the valley is split between Israel and Jordan. The agricultural settlements on the Israeli side of the valley are kibbutzim, socially based communities, whose livelihoods are based heavily on high-tech agriculture. The climate in the Arava is harsh; average annual rainfall is less than 25 mm and summer temperatures can soar to above 40°C. Adaptation of sophisticated farming techniques to the harsh climatic conditions has enabled growing of out-of-season fruit and vegetables, specifically dates, mainly for export.

The majority of water used in the Arava is brackish water pumped from local aquifers. The pumping, desalination, conveyance, management, and pricing of water are all centrally controlled by Mekorot. The amount, quality, and price of water are determined by salinity, which can be very high in the region. Drinking water is locally desalinated and provided by local wells. Distribution is according to a centrally managed quota system with built in provisions for agriculture.

Because of the extremely centralized system of water management in Israel, there exists an artificial buffer zone between the resource and the public's perception of it. Consequently, there is little room for receiving feedback from the public on the acceptance of such a system and the ideological values that helped lead to its creation. The data presented here are an attempt to provide a link between the public's attitudes toward water and agriculture and the role of ideological values in their management.

Of those surveyed, 66.96% were aware that agriculture is the largest consumer of water in the country. In fact, this statement is true for most countries with high levels of irrigated agriculture where water consumption is, on the average, 70% of total water consumed. Subsidized water provided to the kibbutzim by Mekorot has ensured that agriculture remains the dominant economic activity on the kibbutzim. 52.89% of the respondents indicated that the kibbutzim in the Arava were very dependent on agriculture for their livelihood.

Despite agriculture's large contribution to the livelihood of the kibbutzim only 10–25% of the residents work directly in agriculture. This is according to 56.35% of the respondents.[1]

An analysis of the profit generated from the agricultural branches of one of the kibbutzim, Kibbutz Ketura, reveals that field crops and experimental crops have been running at a 3-year loss. According to the Kibbutz Ketura Finance Office, these field crops, such as onions and tomatoes, consume almost 50% of the kibbutz's water budget. The negative contribution of these crops to the kibbutz's economy is also consistent with what is occurring at the national level in terms of the minimal contribution of agriculture to the country's GDP.

[1] Ironically enough, foreign workers, primarily from Thailand, now undertake the majority of agricultural work. Employing foreign workers on kibbutz is a contentious issue as it contradicts the Zionist ethos of the Jew working the land. Indeed, when asked whether employing foreign workers contradicts traditional kibbutz values of working the land, 23.45% of respondents strongly agreed and 33.33% agreed with this statement.

Despite these economic arguments and the risk of environmental degradation due to the overextraction of groundwater in the Arava, people in the region still believe agriculture to be an important pursuit despite the fact that most people do not work directly in agriculture, and economic benefit is, at best, marginal. The trade-off between growing crops in the desert and depleting local water resources may be clear to an outsider but to those living in the region, ideological motivations complicate the issue.

Over 50% of the population surveyed supported the contention that agriculture is important for the national security of the State even if it means using a lot of water.

TABLE 2. Responses (in percentage) by residents of kibbutzim in the Arava Valley to questions about water, agriculture, and ideological values (*n* = 249)

Statement	Response category				
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Agriculture is important for the national security of the State even if it means using a lot of water	12.76	40.74	19.34	23.46	3.70
Agriculture is necessary as a means of making a living in the Arava Valley	27.16	46.50	11.93	11.52	2.88
Helping to make the desert bloom is one of the reasons I chose to live on kibbutz in the Arava Valley	13.17	30.45	26.75	22.63	7.00

This perception was carried over to the local level where almost 76% of the population surveyed believed that agriculture is necessary as a means of making a living in the Arava Valley despite little economic justification. One could argue that Israelis developed a taste for water as they pursued the Zionist dream of "making the desert bloom".[2] Today, almost 43% of the population surveyed in the Arava still agrees with this statement, although 26.75% of respondents were neutral and 22.63% disagreed with this statement.

Additional support for the popularity of Ben-Gurion's statement is reflected in how the surveyed population responded when asked about the desert landscape. More than two-thirds of the respondents felt that date palms and

[2] State Comptroller Report 1990 Report on the Management of Water in Israel. Jerusalem, Office of the State Comptroller, The Government of Israel.

field and vegetable crops help to beautify the region. These data reveal how ideological values pertaining to the development of agriculture at the national level also persist at the local level.

7. Conclusion

In order for a change in the status quo, it is imperative to rethink Zionist ideology both nationally and locally. The objectives of Zionism most influential on water and agricultural policy; mode of life, and territory have left an indelible mark on the Israeli landscape. These objectives have never been fully realized, but Israeli society continues to live as if they have. With respect to mode of life, over 90% of the population is urban. Socialist ideals of rurality and communal living never superseded individualism. In terms of territory, despite massive drives to conquer the desert through agriculture, nearly 60% of the country remains desert with the majority of the population clustered around the coastal plane. Settling the periphery remains controversial and most of the country's borders remain unconfirmed, awaiting the outcome of the peace process. Rethinking Zionism and its hold over agriculture and thus water are necessary steps to openly and responsibly deal with the water crisis facing the region. Only Israel's elites have begun to question the entrenched views of Zionism as it pertains to water and agriculture and the centralized policies that followed. At the national (governmental) and local levels however, the old norms persist. Indeed, it is at both these levels where these norms must be replaced by a more open and decentralized system that includes privatization, market forces, and local-level decision-making. Decentralization can help connect water management to the public's perception of the resource. Because of the little control the public has over the centralized system, changing ideological values that actually represent the situation on the ground will prove daunting. This is borne out by the close match between national policy making and local value systems as revealed by the survey data.

7.1. REFORMING AGRICULTURAL AND WATER POLICY

A first step toward reform is to wrest government supremacy over water resources allocation away from decision-making. Two reports were issued in the 1990s which called for reform. The recommendations of the Arlosoroff Commission calls for reform by many elites (mostly from academia and research) and a report by the State Comptroller in 1990 that clearly laid the blame for the nation's water crisis at the feet of the government over its mismanagement of water (State Comptroller Report 1990, Report on the Management of Water in Israel) have begun to chip away at the notion of centralization. In addition, the economic and environmental costs of supporting large-scale agriculture are now so high that maintaining such a system cannot be justified on the grounds of ideological values alone.

As the water crisis deepens, both supply and demand strategies have been proposed. The success of these strategies depends on a more decentralized water policy that includes public involvement. Decentralization will require significant restructuring at the highest level of decision-making bodies in Israel; simply a shift of responsibilities to other governmental ministries will not be sufficient. The public is now beginning to respond as the water crisis emerges into the public arena. The continued draw down of the Sea of Galilee (and its concomitant recent rise) and the disappearing shore line of the Dead Sea, dusty public parks, public health concerns over water quality, and impending negotiations on water as a part of the peace process have all contributed to wide media coverage. The growing environmental movement in the country has also taken up the cause of the water crisis as one of government mismanagement. Lack of action in improving the situation by government institutions has created an opportunity for a less centralized system to take hold.

Involvement of the private sector is an important consideration for decentralization. Room for private sector involvement is available in investing in and managing the proposed desalination plants or developing new water sources, including wastewater treatment and reuse (Feitelson, 2001). Two recommendations of the Arlosoroff Commission stipulate the restructuring of Mekorot into an interregional water-conveyance body prohibited from investing in or managing desalination plants and transforming the water commissioner into a planning and regulatory agent (Feitelson, 2001). With these changes, government involvement in the day-to-day function of the water system can be diminished.

Desalination and other technological fixes to increasing water supply are not the panaceas to the water crisis as the agricultural lobby and Mekorot would like many to believe. Supply-side solutions, although necessary, are also problematic. Desalination is likely to drive up the price of water (although the price of desalinated water per cubic meter is dropping), increase energy costs and create additional environmental costs due to waste discharges. These drawbacks do not even account for the unsightliness of large industries located at or near the seashore. Nonetheless, these options need to be explored and will play a role in the future. Demand-side management that focuses on water conservation, in conjunction with these technological alternatives has greater chances of long-term success. These kinds of interventions are most effective at a local level.

Increasing local management in decision-making on water supply and demand can generate incentives for conservation and greater efficiency of use. Up until now, ownership of land and water has rested in the hands of the government. The Israeli Lands Authority issues long-term leases to individuals and communities, primarily agricultural settlements. Consequently, there are few permanently held titles to land and water. If local communities were allowed to manage public lands and water resources they would have strong incentives for prudent use. When the role of the government is limited to distribution and quality control, and decisions regarding use are made at local levels, water can be used efficiently. Local communities will then have the choice to devote water to uses other than agriculture. For example, alternatives to agriculture such as industry and tourism can be adopted, where available water is spread across a variety of sectors and not concentrated in one large sector. Accordingly, decisions on the use of water will be made on maximizing efficiency at a local level. Conservation of water will be important because without government subsidies and quotas, water will be more expensive to use.

Many of the agricultural settlements across the country are small close-knit communities. They also consume the most water. Scaling down hydrological subsidies and introducing market-based policies together with some form of local control can provide for long-term management. On a local level, the costs and benefits of water use practices can be easily monitored because in close-knit, small communities cheaters and free riders can be sanctioned. Decisions based on conservation and efficiency are likely to take hold at this level where behaviors and practices can be monitored. As privatization grows and competition in the water sector increases, the power of local decision-makers regarding the water supply and demand will increase. Establishing regional water authorities can also help further the decentralization trend (Feitelson, 2001). As these settlements become less agricultural, the continued ideological rationalization for cheap water for agriculture will weaken. Shifting water from agriculture to the urban domestic sector as demand for water in agriculture will decrease making the demand for large-scale investment in desalination and other such projects seem less urgent. Price is an important lever in this regard. Price elasticity is high in the agricultural sector because farmers will respond to increasing water rates and scaling back subsidies. Such fiscal leverage can reduce consumption in agriculture and allow a shift of resources to the domestic sector where price is relatively inelastic. Greater decentralization and market-based policies also mean greater flexibility in exploring alternative options toward agriculture. The removal of expensive agricultural products from production (e.g. citrus) and the liberalization of import and tariff policies have greater chances for success when regional and local authorities have a say in policy.

As the Israeli system is currently structured with a nationalized water management body that is aligned with an agriculture-centered Zionist ideology, the country is tied to inefficiencies with dramatic negative consequences. Dogmatic adherence to an allocation system that evolved from ideological values hampers improving the situation now and in the future. In viewing the solution to the water crisis as one of access alone, technological fixes have been favored. Many in Israel today hold this view. It is clear, however, that technology is only part of the solution. A sustainable use scenario is one that takes both supply and demand-side management strategies into account and opens up the system to stakeholders at all levels. Therefore, the degree of responsiveness to discrepancies in the present need not adversely affect those in the future. In other words, reducing water allocations to agriculture now need not require discounting future supplies.

Nonetheless, these rational arguments for a solution to the country's water crisis are couched within an ideological context that still resonates strongly with decision-makers and the public. In making the rational implementable, we must first honestly and forthrightly confront our Zionist heritage.

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TRADING THE RAIN: SHOULD THE WORLD'S FRESH WATER RESOURCES BE AN INTERNATIONALLY TRADED COMMODITY?

JOY BRAUNSTEIN *
University of Pittsburgh, Graduate School of Public and International Affairs, 3601 Posvar Hall, 230 S. Bouquet St, Pittsburgh, PA 15260, USA

Abstract: Whether water should be a commodity, subject to ownership, trade, and pricing based on supply and demand economics, or considered a common good, subject to principles of human rights and environmental protection has become a subject of international debate. This debate takes on an exceptionally critical meaning to regions, which are water-stressed or water poor, and become much more complicated where the waters in question are transboundary in nature, such as in the Middle East. As the entire set of arguments, which are analyzed here for the strength of their evidence, tends to be framed around the idea of an impending global water crisis, to those involved in alleviating this problem this paper may serve as a useful diagnostic tool.

Keywords: water management; transboundary cooperation; international trade; human rights

1. Introduction

This paper examines whether water should be considered a commodity subject to international trade laws, a common good subject to the principles of human rights, or some combination thereof. This issue is hotly debated in public policy, commerce, development, and governance circles and is rife with emotion. The rhetoric of these arguments, put forward by all of the nations, multinational corporations, nongovernmental organizations (NGOs), and individuals that make up civil society tends to center around solving a water crisis of global proportions. In order to understand the spectrum of these arguments one must

*To whom correspondence should be addressed. Joy Braunstein, University of Pittsburgh, Graduate School of Public and International Affairs, 3601 Posvar Hall, 230 S. Bouquet St, Pittsburgh, PA 15260, USA; e-mail: joy.braunstein@gmail.com.

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understand the assumptions that they are framed around. As such, the facts and implications of the world's impending water crisis are presented as the starting point of this paper. Having digested this information and reaching some understanding of the situation as it appears to the experts, the debate takes on a new richness and can be defined in terms of management styles and philosophies as they relate to varying perspectives on resource management. It is these philosophies that underlie the arguments put forth, arguments which provide, for the most part, legal, economic, or human rights evidence as their basis. Each argument, therefore, is then examined in terms of the evidence used and what that evidence is intended to infer.

A conclusion cannot be drawn on the merits of any prescribed management tools until we truly understand how those inferences translate into supposed outcomes with benefits divided and assigned among various segments of the global society. Analysis of the evidence used by each camp in framing that rhetoric will thus be useful to the issue's judges in determining the appropriateness of choosing one perspective as means to managing a crisis. For the rest of us in civil society, this analysis will help to shed some light on the implications of one perspective emerging as the dominant global philosophy of global water management.

1.1. FACING A GLOBAL WATER CRISIS

It is almost universally acknowledged that the world is on the verge of global water crisis. It is becoming indisputable that there is not enough clean water available to meet today's populations' needs – much less, given population growth and development, those of the future. Some parts of the world are already seeing the effects of shortage and pollution, while others are either just beginning to realize them or are observing them with a watchful eye. This situation is already keenly felt in India, China, and Mexico, and even in the USA there is a problem of "deteriorating water quality" (Nachmani, 1994). Further compounding the situation are the planet's hydrological realities.

1.1.1. The Crisis, Facing Facts

Though it can be shifted from one place to another, water is finite in amount and locked into a naturally recharging hydrologic cycle. Water may be consumed or evaporate, but it reccurs as rainfall or snowfall, which in turn flows through rivers and streams into lakes, ponds, wetlands, and seas and/or filters through the ground into aquifers where it eventually ends up in the atmosphere again. Though there is over 326 million m^3 of water available, in total about 3,100 m^3, or more than one trillion gallons, of that is in the atmosphere at any given time and only about 60,000 m^3 of fresh water is easily accessible in surface water on the earth at any given time. Another 2,000,000 m^3 of fresh water is stored in the Earth, most within one-half mile of the surface and almost 7,000,000 m^3 as ice. Essentially, this breaks down into about 2,060,000 m^3 of naturally occurring (without utilization of the seas or the ice caps) water available for human use, or (at the time this paper was being written and the world's population was approximately 6,406,370,000) about 0.0003215 m^3/ person.

Even not defined in geometrically complex terms, simply calculating the water balance as it relates to the population would be an exercise in futility for at least two reasons. The first of these is that water is not distributed evenly around the world. This leads directly to the other problem, that the statistics projecting the amount of water available for human consumption entirely ignore water quality issues that de facto lower the supply balance. While the second issue is of critical importance because of the costs involved, both in terms of human health and the economics involved with water pollution mitigation, the primary driving force behind the debate discussed in this paper is the distribution of water.

Today, over 1 billion people in the world do not have access to a reliable source of water to meet their basic needs, estimated at about 50 L per person per day; many of them are among the world's poorest. The World Bank has projected this scenario to become worse, assuming a population projection of 7.2 billion in 2025, with world water consumption expected to double over the next 20 years. *Water stress* is defined as those countries whose annual water availability is defined by periodic water shortages and *water scarcity* indicated by chronic shortages, which may cause major human and environmental security issues linked to food production, economic development, and ecosystem health (World Resources Institute). If this does not paint a stark enough picture, consider that the distribution of the population without adequate water supply and the distribution of people without sanitation systems are almost identical, with the more arid regions of the world facing a true crisis of epic proportions.

1.1.2. And the Issue Is?

A huge disparity exists between the water consumed in many of the more resource rich countries and those that face a direct crisis, as many resource rich countries consume many times the amount per person of their counterparts in less resource rich countries. It is striking to look more closely at the data and realize that essentially every person in the developing world consumes between 20 and 50 times less than those in developed countries. This consumption, or, as some consider it, overconsumption, is caused by a combination of the developed world's domestic and luxury uses and the inefficient irrigation methods and agricultural practices of the developing world. Such ineffecient uses and overconsumption compounds ecological damages caused by strain placed on the world's surface water resouces from pollution, deforestation, destruction of wetlands, and the rechanneling of rivers.

It is somewhat paradoxical that the issue at hand does not necessarily start with conservation, i.e. demand management vs. interbasin transfer or water movement, i.e. supply management, as the appropriate approach for solving the world's water problems. Rather, the debate seems to encompass the assumption that water will somehow be supplied to the entire thirsty world. It is the philosophy under which water supply will be approached by the world that sparks the majority of the controversy and so the question is asked: Is water simply a commodity to be internationally traded or is it a global common good and a universal human right?

2. Perspectives on Solving the Global Water Crisis

Karen Bakker of the University of British Columbia has posited that water resource management defines the very nature of water for a given society. This assumption fits nicely into the topic at hand by defining three types of water management, which, when combined with her work defining the implications of a *commodity* or *commons* approach toward water management produces an interesting set of implications involved in the policy debate (see Tables 1 and 2). By adopting this perspective, it becomes possible to assume operational definitions under which to analyze the arguments involved such that the public utility and community models for water management are most compatible with the Commons/Human Right philosophy and the commercial model is most compatible with the Commodity/Classical Economics philosophy. The hybrid of the two sides of the spectrum, or the middle ground is represented by the Public Utility Model which is closely related to a philosophy adopted by the United Nations (UN), the humanitarian compromise, that water should be a

TABLE 1. Water management philosophies

Water management philosophy	Description
Public utility model	Government control justified by economic and ethical arguments that water is a public good, a necessary precondition to participation in public life and a material emblem of citizenship
Commercial model	Management and/or ownership of infrastructure by private, for-profit corporations
Community model	Managed by cooperatives without direct government involvement, democratically controlled by the users of the goods and services provided

TABLE 2. Framing water resources

	Commons	Commodity
Definition	Public good	Economic good
Pricing	Free or “lifeline”	Full-cost pricing
Regulation	Command and control	Market-based
Goals	Livelihoods	Efficiency
Manager	Community	Market
Access	Human right	Human need

tradable commodity in a global economic force but subject to pricing constraints that take into account nonmarket valuations related to human rights, culture, and the environment.

2.1. THE TERMINOLOGY

As this debate is further examined, it is a helpful exercise to think about a few key water terms as defined by the UN and widely accepted among the water policy community. The *value of water* is measured in terms of its benefit to its users. On the other hand, the *price of water* is equivalent to the charges levied from the consumers. The *cost of supplying water* is related to the capital and operating costs for extracting, treating, and transferring water to the point of use. *Full cost recovery* is when users pay the full cost of obtaining, collecting, treating, and distributing water, as well as collecting, treating, and disposing of wastewater. Finally, *externalities* are the benefits or costs which occur to parties that are not considered directly involving the uneconomic transactions of water exchange.

3. The Policy Debate

The sides of the debate, as earlier alluded to, are two extremes that view water as either a pure commodity and or purely as a commons, but now with the middle ground which recognizes water as both a tradable resource and as a human right. These perspectives are not purely rooted in evidentiary arguments; however, they cross over into ethical and ideological imperatives and are the possession of champions who work hard to turn the world’s hearts and minds in favor of their version of normative thinking on how to solve the world’s water crisis.

3.1. WATER AS A COMMODITY

To those who believe in the total commoditization of water, the pervasive ideology is similar to that of classical economists. Proponents, such as Professor Martin Jaffe (University of Illinois at Chicago), believe that the free market works better than any government interference for resource management. They use legalistic arguments to infer that conservation and appropriate levels of consumption will naturally occur in an economic world. Economically this is because, so the argument goes, water prices are assumed to be elastic and will account for the scarcity that exists by rising as less water is available, thereby preventing its overconsumption. Thus, economic agreements are the best measure under which to solve the water problem.

For the Strict Commodity camp, the 1947 General Agreement on Trade and Tarrifs (GATT), the WTO's General Agreement on Trade in Services (GATS) and the North American Free Trade Agreement (NAFTA) provide a legal backing for their rationale. GATT speaks to water, they would say, not as an exhaustible resource which is due nonarbitrary or unjustifiable discrimination between countries' protectionist water-export control measures but as a product or good. Dendauw (2002), points out that under GATT Article XI:

> No prohibition or other restriction other than duties, taxes, or other charges, whether made effective through quotas, import or export licenses, or other measures, shall be instituted or maintained by any contracting party on the importation of any product or any other contracting party or on the exportation sale for export of any product destined for the territory of any other contracting party.

NAFTA has a similar provision, as Dendauw also points out:

> under NAFTA, it is unlikely that a ban on the export of water as a good such as bottled water could be sustained because NAFTA Article 309, which is similar to GATT Article XI, prevents contracting parties from restricting or prohibiting the export of goods.

GATS is more clear-cut, indicating that water supply should not be restricted in pricing regulations that would prevent it from being traded on the free market.

Thus, says Jaffe (2002), "commodifying our water resources is probably the cheapest and most efficient way to manage them while also protecting the long-term sustainability of our shared waters." This is a perspective that has begun to garner some support in Middle Eastern countries, where the water has traditionally been owned by the State, or the people, but never more than temporary rights to a limited and defined quantity by any one individual or corporation. In Israel, for instance, this has taken shape with the 2001 passage of the Israeli Water and Sewage Corporation Act which requires the privatization of water and sewer services and provides for the privatization of desalination plants. The country also began, though it did not complete, negotiations with Turkey to ship water tankers filled with fresh Turkish water to Israel, in an indication of a general belief between the two countries that water should have not only a pure economic value, but should be an internationally tradable commodity on a scale previously inconceivable. Privatization, has also been argued, will also help to avoid national and international conflicts over water resources by taking the rights of water use out of politics and placing it within international business venues.

3.2. WATER AS A COMMONS

There are also people who believe that water should not be subject to international market forces as a pricing mechanism. This ideology is emotionally charged and considers a description of water as a common heritage of mankind and a basic human right that, like the air, is necessary for life and thus not subject to being negotiated as a commodity. They do not distinguish the uses of water as a necessity; however, for drinking, hygiene, and food production, they make a series of arguments that are legalistic and ethical to make their point.

The legal arguments put forth by the Water As a Commons group are a response to those who argue the other end of the spectrum. They point out that water is, because of its scarce and degraded nature, an exhaustible resource under GATT and that under NAFTA water should not be considered a product up for sale in its natural state, as put forth in the 1993 Joint Statement by the governments of Canada, Mexico, and the USA. They further argue along that the Public Trust Doctrine principles that resources vital to the common good of all people should be protected by the government for the benefit of all and to the exclusion of private ownership.

The ethical arguments are grounded in concepts of ecological science, cultural anthropology, and human rights and work to counter the commercial argument that traded water will quench a thirsty world. As stated by Versluis (2004):

> it's wrong for an international corporation to pump groundwater out of a region's aquifer for private gain. Why? Because the water does not belong to the corporation; the groundwater is a public resource; citizens rely on it for their water supply; the groundwater is essential to the local and regional ecology.

Furthermore, as pointed out by Jackson (2001) globalization threatens to turn "clean, fresh, water" into a commodity which the world's poor cannot afford to buy. Currently, as the World Health Organization (WHO) asserts, over a billion people do not have access to water, causing a child to die every 8 s from contaminated resources.

The type of pricing that NAFTA and other international trade rules call for will only make it more difficult for less wealthy developing countries in water poor regions, whether because of quantity or quality problems, to provide critical resources to their entire populations. This is true because a market based approach requires water to be sold to the highest bidder despite the price to society or the environment (Rizzo, 2002). This is exceptionally critical, the argument goes, given that in the next generation over half of the world's population will not have access to water due to depletion, pollution, and diversion. This will affect not only drinking water sources but hygiene, food, and waste management as well. As Linda Perkins of the environmental group FLOW points out, this will also have tremendous implications for the whole ecosystem as it will degrade the cultural and spiritual value placed on water for the trees, the animals, and the fish that depend on flowing water for their life cycles and health.

In the Middle East, these concerns have been raised by a number of private authors and NGOs. Regarding the idea of privatization in Israel, these opponents point out that the Water and Sewage Corporations Law of 2001 is a direct contrast to the time-honored Water Law of 1959, which established that water was a public property, owned by the government and thus the people of Israel. Similar laws exist in other parts of the Middle East, which would naturally conflict with the principles of privatization. Furthermore, in the case of Israel, privatization does not assure for basic environmental health components of water and sewage, as people too poor to pay may be subject to disconnections, nor does it assure that nature will be provided a sufficient amount of water.

3.3. THE HUMANITARIAN COMPROMISE

A third perspective exists somewhere between the two extremes described above. This one is rooted in economic pragmatism, acknowledging that the demand for water is elastic only at a point above a certain basic necessity level, but below that the demand per person is inelastic, and that the free market cannot capture the true value of the resource. The ideology behind this perspective is rooted in economics as the appropriate rational decision making tool for resource distribution and consumption, provided that nonmarket valuations are used to set pricing levels.

As noted on the website of the United Nations Educational, Scientific, and Cultural Organization's (UNESCO) World Water Assessment Programme, there are a number of statements and declarations which the UN and other supporters of the humanitarian compromise believe should guide the pricing of water internationally. Most important of these are the 1992 *Dublin Statement on*

Water and Sustainable Development, *Agenda 21*, the 2000 *Ministerial Declaration of the 2nd World Water Forum*, and the 2003 *Ministerial Declaration of the 3rd World Water Forum*. The pertinent language from each is listed below, beginning with the Dublin Statement on Water and Sustainable Development (1992):

> Principle No. 4: Water has an economic value in all its competing uses and should be recognized as an economic good. Within this principle, it is vital to recognize first the basic right of all human beings to have access to clean water and sanitation at an affordable price. Past failure to recognize the economic value of water has led to wasteful and environmentally damaging uses of the resource. Managing water as an economic good is an important way of achieving efficient and equitable use, and of encouraging conservation and protection of water resources

Agenda 21, Chapter 18 (UNCED, 1992):

> Water should be regarded as a finite resource having an economic value with significant social and economic implications regarding the importance of meeting basic needs.

Ministerial Declaration of the 2nd World Water Forum (The Hague, 2000):

> To manage water in a way that reflects its economic, social, environmental and cultural values for all its uses, and to move towards pricing water services to reflect the cost of their provision. This approach should take account of the need for equity and the basic needs of the poor and the vulnerable.

Ministerial Declaration of the 3rd World Water Forum (Kyoto, 2003):

> Funds should be raised by adopting cost recovery approaches which suit local climatic, environmental and social conditions and the "polluter-pays" principle, with due consideration to the poor. All sources of financing, both public and private, national and international, must be mobilized and used in the most efficient and effective way.

Included in the value of water that should be accounted for, according to the UNESCO, are those attached to religions and ecosystems. When included in any pricing system, along with the externalities and needs presented above, these values will capture an appropriate and correct market worth. This perspective infers that the global water crisis can be solved with government interference, leveraging of resources, and appropriate pricing, but fails to describe on-ground implementation of providing water at the right cost to the world.

This type of water and sewer management scheme could work in areas of the Middle East, like Israel. With the advent of desalination on a large scale in Israel, the total pressures of a limited quantity of fresh water is eased somewhat, which seems to allow for more consideration of alternatives. It may be possible for water to become more efficiently managed and subject to full-cost pricing, but at the same time be reserved as a right which assures that each person will have their basic needs met and that nature will receive the water necessary to operate as a functional ecosystem.

4. Analysis

Given the nature and importance of the problems inherent in an impending international water crisis, each perspective should be considered as a potential solution in terms of practicality and pragmatism as both an acceptable ideology and outcome. Only understanding how these stack up against the ideal outcome of averting the problem can the world make a responsible and informed decision on how water is best approached: as a market commodity, as a commons, or as a hybrid of the two.

4.1. WATER AS A COMMODITY

This perspective works to solve the world's water problems as long as there is no market failure. Market failure will exist where either all of the traditional economic assumptions are not met,[1] or where there are other problems, thereby making it impossible to reach economic efficiency. In the case of the international commodification of water, there is evidence of a market failure, thus this perspective works only to a point, which defeats the purpose of calling it a solution to the problem. There are two prominent examples of this failure, the first in Bolivia where water privatization caused civil unrest and forced government intervention, and the second in Michigan, USA, where externalities have not been accounted for in the profits made by pumping and selling bottled water.

In Bolivia, the poorest South American country, an outside corporation, Bechtel, was contracted to manage the city of Cochambamba's water systems under World Bank privatization requirements. Under Bechtel, water prices shot up rapidly, causing a revolt among a large coalition of labor, peasants, and students in what is now referred to as a Water War. The strike caused the

[1] Economic Assumptions necessary for economic efficiency: (1) numerous small firms; (2) homogeneity of product; (3) freedom of entry and exit; and (4) perfect information.

government to break its contract with Bechtel, who is now suing for $20 million (Jackson, 2001).

A different type of market failure is exemplified by a recent case where Perrier (recently taken over by Nestle) gained the rights without payment to water in Minnesota. Four-hundred gallons of groundwater a minute are pumped out of an aquifer and piped to a bottling plant, excluding the people and ecology in the area naturally served by the aquifer from free access to the resource (Versluis, 2004).

These are the types of situations which could become issues to a larger extent in the Middle East and Israel if full-scale privatization were to move forward – situations which have not been fully accounted for by the laws or the economists pushing the perspective. The trend towards this public unrest is already being seen as the government has failed to make its privatization process transparent and take into account the societal issues associated with moving water from a public to a private management scheme.

Besides the market failures, the Pure Commodity camp have not yet proven their legal case to the exclusion of those who believe that water should not be subject to international trade and market forces.

4.2. WATER AS A COMMONS

The arguments made by the Water As a Commons camp are primarily a reaction against another attitude and offer(s) no real mechanism or authority to assure that the world's population is served with the water necessary for life and not priced out of it. The argument that water should be treated as an exhaustible resource, thus excluding it from international trade negotiations, and that subjecting it to market forces for pricing will assure that most of the world's population cannot afford the critical resource is undeniably logical and grounded in ethics. It, however, does nothing to supply water to a thirsty world and thus fails in ideological pragmatism and in practical problem solving. Furthermore, in places like the Middle East, simply holding water as a public good has encouraged an exceptionally politicized and inefficient mechanism for assigning usage rights of the scarce resource to a diverse population and user base. These inefficiencies have been widely acknowledged and were part of the driving force behind the recent Israeli privatization movement.

To avail itself as a solution, the backers of perspective must present clear distinctions between necessary water and water used for other purposes and consider the economic realities of a need for market pricing on water considered above and beyond necessity. It also needs to recognize the costs and difficulties with the delivery of necessary water. As an example of this, consider the Palestinian territories, where large parts of the population exist without a reliable source of necessary water. This is a situation which has been labeled as a human rights travesty and one in which the world cries foul at the idea of charging for water delivery. The Palestinian issue, and other situations like it, only gets worse each passing day as no better mechanism than the JWC is put forward to get water to this thirsty population.

4.3. THE HUMANITARIAN COMPROMISE

In a flawed attempt to be both pragmatic and practical, the UN has proposed a perspective on the water crisis that on the one hand is economically rational and on the other takes into account human rights, culture, and the environment. The idea behind this approach is that government has a role in both the national and international arenas in managing critical natural resources and the pricing and delivery of them to people. This is done by the UN in a manner consistent with what they do best, by making wide declarations of values and norms and by providing principles that the world will hopefully voluntarily adhere to because they inspire excitement and commitment and a sense of justice. The problem here is that these principles are inherently imprecise; their generality does not provide rules or solutions or spell out any specifics as to how the water crisis will be averted. As such, while their ideology leans towards the pragmatic, the practicality of the approach fails under the weight of having no on-the-ground effectual application.

5. Conclusion

In considering the major arguments put forward as to how to best assure that the world's water shortage problems do not deteriorate into a full blown global crisis, it becomes apparent that there are pitfalls in adopting any of the perspectives discussed in this paper as the normative ideology.

Those that argue that water should be a pure commodity have a good approach that is grounded in economic rationality – but it goes too far, holding the potential to leave billions of people perpetually thirsty, and is too offensive to too large a segment of the world's thinkers and populace. The next approach is at the other extreme; it ignores the fact that it costs money to provide water to populations and that the most efficient method in an economic world of distributing resources is through the economic system. Given that, the commons approach at least assures that no one can be deprived of necessary water due to their inherent poverty. The final perspective, that proposed as a middle ground, in its own inadequacy to provide a solution, captures the essence of the problem itself.

The hydrogeological conditions of the earth are a reality; as is the planet's population dynamics and political economy. The problem of transboundary water movement in the case of extreme shortages in poor regions of the world encompasses all of these, creating one of the most profoundly complex international policy problems imaginable. As cynical as it may seem, examining this problem makes it evident that there are limits to our human ingenuity at the moment – that sometimes we can use the best, most educated brains to search out solutions to a problem, only to find that no solution is good enough. It is valuable to acknowledge this and recognize that each perspective, in presenting evidence publicly that is supposed to hold a solution which will ease a pending catastrophe, leaves us unprepared for a real crisis. Only by embracing that the current thinking is in fact limited, can we begin to move toward finding a way out of our situation – and we surely must, as the consequences of not doing so are much too dire to allow.

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SECTION III

CASE STUDIES

TRANSBOUNDARY STREAM RESTORATION IN ISRAEL AND THE PALESTINIAN AUTHORITY

LIOR ASAF[1*], NETA NEGAOKER[1], ALON TAL[1], JONATHAN LARONNE[2], AND NADER AL KHATEEB[3]

[1]*Arava Institute for Environmental Studies, Kibbutz Ketura, D.N. Hevel Eilot, 88840, Israel*

[2]*Ben Gurion University of the Negev, Beer Sheva, 84105, Israel*

[3]*Water and Environmental Development Organization, Bethlehem, P.O.Box 844, PA*

Abstract: Within Israel and the West Bank and Gaza Strip (WBGS), there are 15 streams that cross the Palestinian/Israeli Green Line. All originate in watersheds located in the Palestinian Authority, or in lands that will eventually be outside Israeli jurisdiction, and then flow into Israel toward the Mediterranean Sea, flow east to the Dead Sea, or the Jordan River. These transboundary streams of Israel and Palestine are plagued by severe pollution, posing a serious health hazard to humans and devastating the natural ecosystems.

Several factors have contributed to the severity of pollution in these streams. For many years, most streams were transformed into sewage conduits collecting raw sewage or low-quality effluent all year round. The region's climate is semiarid and increasing demand for water has led to overpumping of the available groundwater, drying up of the headwaters of many streams. A range of pollutants, including nonpoint agricultural runoff, urban stormwater, and discharge from industrial sites can also be found in many streams.

In 1994, the Ministry of the Environment established the River Restoration Administration as a coordinating body for actions taken by various governmental and nongovernmental bodies to restore or at least rehabilitate damaged streams. Although stream restoration constitutes a paramount environmental priority for both parties, the lack of a clear and relevant model that identifies and quantifies the key parameters for stream restoration including water flow, nutrient concentrations, and other contaminant loadings from nonpoint and point sources on a catchment scale across the virtual borders has frustrated all

*To whom correspondence should be addressed. Lior Asaf, Arava Institute for Environmental Studies, Kibbutz Ketura, D.N. Hevel Eilot, 88840; e-mail: aies24@ketura.ardom.co.il

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previous restoration attempts. The ultimate aim of the current research is to lay the foundations for an effective river restoration strategy for Israel and the Palestinian Authority. Using a "catchment scale chemical and biological monitoring network," the total pollution loadings into two transboundary streams whose geographic boundaries cross over the Israeli/Palestinian Green Line (the Zomar/Alexander and Hebron/Besor/Gaza) are to be characterized. This will for the first time enable a more systematic and comprehensive assessment of intervention options, their affect on stream restoration, and relative cost-effectiveness.

Keywords: stream restoration; water pollution; Israel; Palestine

1. Introduction

Within Israel and the West Bank and Gaza Strip (WBGS) there are 15 streams that cross the Palestinian/Israeli Green Line. Twelve of these are major streams that flow year-round in a westward direction toward the Mediterranean Sea and the other three flow east to the Dead Sea or the Jordan River. All of them originate in watersheds located in the Palestinian Authority, or in lands that will eventually be outside Israeli jurisdiction, and then flow into Israel (these include: the Na'aman, Zipori, Kishon, Taninim, Hadera, Alexander, Yarkon, Ayalon, Soreq, Lachish, Besor, and Beer Sheva streams). At least part of each of these streams can be defined as highly polluted, posing a health hazard to users, endangering flora and fauna and unfit for recreational or consumptive uses (see Figure 1).

Several factors have contributed to the severity of pollution in these streams. The region's climate is semiarid with minimal exploitable surface water to support the region's rapid population growth and urbanization. Increasing demand for water has led to overpumping of the available groundwater and thus a drying up of the headwaters of many streams. A range of pollutants, including nonpoint agricultural runoff, urban stormwater, and discharge from industrial sites, can be found in many streams. River restoration and the recovery of the river's environmental and social functions have taken an increasingly important place on Israel's public agenda in recent years. River restoration, planning, and management are meant to achieve a wide range of targets in different and varied aspects (Kaplan, 2004).

Accumulated experience shows that river restoration is a lengthy process, lasting many years. It involves multipurpose activities, including the cessation of sewage discharge, cleanup of riverbeds, re-creation of flow paths, and the

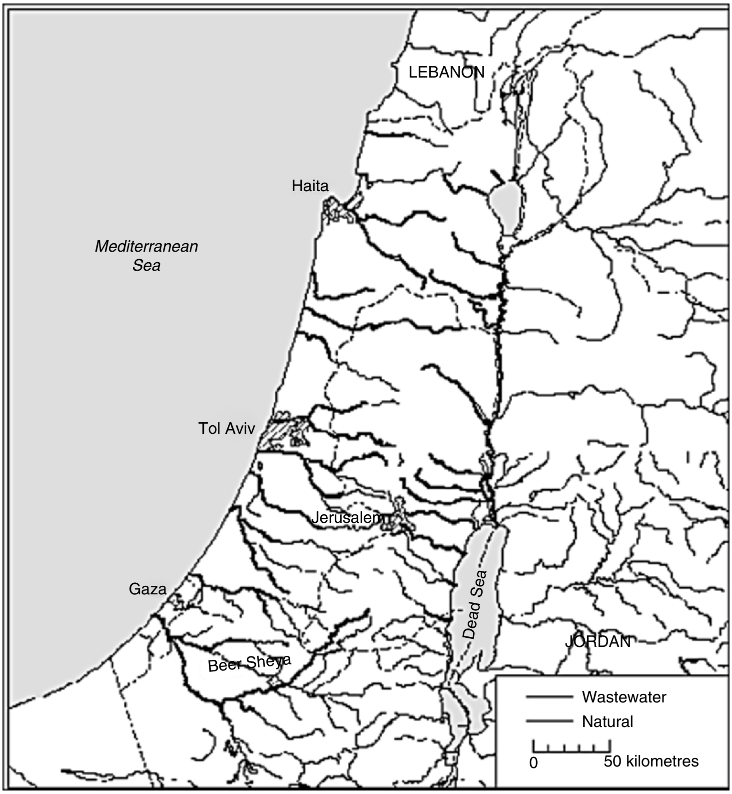

Figure 1. A general location map showing some of the ephemeral stream in Israel and the Palestinian Territories that have been affected by wastewater flow. (From Hassan and Egozi, 2001).

facilitation of the natural processes of habitat renewal. Restoration of water to rivers is an absolute necessity, with primary ecological and landscape impacts, and with high value in terms of its contribution to leisure, quality of life, and tourism services (Bar Or, 2000).

Stream restoration ostensibly constitutes a paramount environmental priority to both parties. Yet, there is insufficient cooperation between Israel and the Palestinian Authority. The cooperation is hampered by the security and political instability in the region and absence of a direct mechanism to manage the transboundary catchment across the political boundaries. There is a need of a clear and relevant watershed framework that identifies and quantifies the key parameters for stream management. These should include water flow, nutrient concentrations, and other contaminant loadings from nonpoint and point sources on a catchment scale across the virtual borders. The lack of such a model has frustrated previous restoration efforts.

The present research was designed to lay the foundations for an effective river restoration strategy for Israel and the Palestinian Authority. Specific research objectives were defined:

- To identify and quantify the key parameters for stream restoration including water flow, nutrient, and other contaminant loadings from nonpoint and point sources, and discharge limits (especially from municipal wastewater treatment facilities).
- To extrapolate the maximum loading limits for the transboundary streams evaluated.
- To establish a monitoring program that will offer a more thorough characterization of ecological health in local transboundary streams and offer baseline values to assess future reduction strategies.

1.1. THE HEBRON/BESOR DRAINAGE BASIN AS A CASE STUDY

The Hebron/Besor drainage basin is the largest in Israel or the Palestinian Authority (3,500 km^2). It is located in the south of Israel in the northern Negev (Figure 2) as well as the south of the West Bank and parts of Gaza. The Hebron/Besor basin area varies spatially in geography, climate, geology, land use, and vegetation. The drainage basin spreads from the southern Hebron Mountains in the north within the Palestinian Authority to Sde-Boqer in Israel in the south and from the northern Negev in its central section to the Mediterranean Sea in the west where the stream estuary is located in the Gaza Strip.

The climate in this basin is semiarid to Mediterranean, characterized by a long dry season and short wet seasons with two short transition periods during the spring and fall. The wet season occurs during the winter, influenced by Mediterranean fronts (Alexandrov et al., 2003). These are characterized by long rainfall duration and low rainfall intensity. Precipitation in the basin is not evenly distributed, with mean annual precipitation of 500 mm in the northern part of the basin, 300 mm in the west, and less than 70 mm in the south. During the transitional seasons there is influence from the Red Sea trough (convective rain), characterized by short rainfall durations and higher intensity that cause most of the flood events in the Negev (Godreich, 1998; Kahana et al., 2002). On average, there are two to three flood events per year, while some years may have no floods at all (Kahana et al., 2002).

The main land uses in the watershed are undeveloped lands, agricultural, and urban areas. Yet, industry, mining, quarrying, and manufacturing are important activities that influence the watershed and the stream water quality. The major point pollution source is raw sewage discharge from the city of Hebron into the Hebron Stream. The Hebron Stream drains the domestic sewage of the city of Hebron and the Israeli settlement of Qiryat Arba (together approximately 200,000 residents). In addition, untreated sewage as well as the wastewater from almost 100 industrial facilities reach the stream. These sources change the fundamental nature of the ephemeral stream, converting it into a de facto sewage conduct with a permanent base flow that continues for more than 100 km downstream. Additional point pollution sources on the Israeli side of the watershed are very low-quality treated effluents that are discharged from Dimona into the Ar'ara – Beer Sheva Stream; untreated wastewater discharges from Ofakim into the Patish Stream; and on occasion, treated wastewater leaks out of municipal waste facilities in the city of Beer Sheva into the Beer Sheva Stream (The Ministry of Environment, 2003).

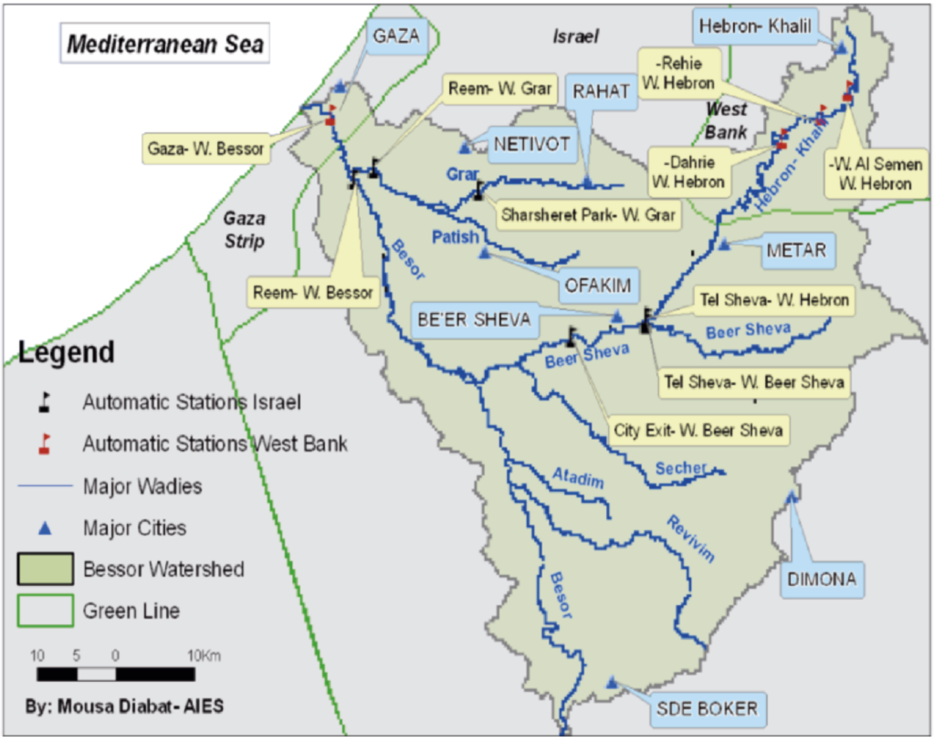

Figure 2. The Hebron/Besor/Gaza Stream streams watershed and the monitoring Network.

2. Methods

2.1. MONITORING AND SAMPLING

In a semiarid setting, the stream channel is active less than 2% of the time, or 7 days/year (Reid et al., 1998) and characterized by flash floods, which makes it difficult to monitor and understand the chemical and biological processes in the stream, as well as its sediment and pollutants transport mechanism. Therefore, in each watershed a detailed monitoring plan was designed and implemented that including the location of six automatic monitoring stations (Figure 2). This stage of the project involved extensive coordination and negotiation with the government authorities who are responsibility for streams in Israel and the Palestinian Authority. In the Hebron/Besor watershed an addition of three stations funded by the Besor Drainage Authority were integrated into the monitoring system. Three monitoring stations are stationed on the Palestinian side: two contiguous to the Hebron Stream (Figure 2) in the West Bank, and in the future one station will be placed in Gaza when political turbulence subsides and the security situation allows.

Each of these hydrometric stations include a pressure transducer (with a resolution of 10 mm), a data logger, a salinity probe, an automatic water sampler activated during floods in the stream, and a cellular communication system. Because the stations measure water from areas of different sizes and land uses, the impact of these characteristics on the quantity and quality of stream water and sediment transport during flow events will be evaluated during the coming winter season (unfortunately, to date there has only been one major storm event since last winter).

2.2. WATER-SAMPLING ANALYSIS

The characteristics of base flow and two flow events in the 2005 winter season were determined by 77 water samples that were taken from various locations. In the field, measurements of water temperature, pH, dissolved oxygen, and electrical conductivity (EC) were taken using electrodes. These samples were analyzed in the laboratory for major components and trace elements. The analysis of major ions was carried out at the laboratory of the Institute for Desert Research, Ben-Gurion University of the Negev. Following the determination of bicarbonate (by acid–base titration, ± 5 mg/L), all samples were filtered through a 0.45 μm filter. Calcium, magnesium, sodium, and potassium were measured using atomic adsorption (Perkin Elmer, ±1%). Chloride, sulfate, nitrate, and bromide were measured using ion chromatography (Dionex, ±1%). Ammonia was measured pectrophotometrically (Hitachi-U2000, ±0.05 mg/L with a detection limit of 0.03 mg/L). The analysis of trace elements was carried out at the Interdepartmental Laboratory of the Faculty of Agricultural, Food and Environmental Quality Sciences of The Hebrew University of Jerusalem in Rehovot. Analyses for trace elements were carried out using inductively coupled plasma-atomic emission spectrometry (ICP-AES) according to EPA method 6010B. Effluent parameters including biological oxygen demand (BOD), total organic carbon (TOC), and dissolved organic carbon (DOC), microbial analyses (general count of cells, coliform bacteria, and fecal coliform bacteria), and nutrients (organic nitrogen and organic phosphorus) were determined according to standard methodological procedures.

2.3. WATER-SAMPLING ANALYSIS

Measurements of base flow water discharges (Q) were conducted at several stations along the Hebron/Besor Stream. Stream flows were calculated using the equation $Q = A*V$, where A is the cross-section area of the stream (m^2) and V is the mean stream water velocity (m/sec). After a cross-section area was chosen and measured, water velocities of the water columns were measured in 0.20 m intervals, using an electromagnetic flow velocity meter – (Marsh-McBirney Inc., flow-mate model 2002). The mean velocity of a water column was measured at 60% of the depth (from the water level). The total discharge is a summation of all partial discharges from the individual intervals.

3. Results and Discussion

3.1. BASE FLOW WATER DISCHARGES

Initial results show a decrease in the base flow along the stream after the initial upstream sewage discharge (Figure 3). In the summer about 88% is lost from the upstream to downstream. The direct evaporation from the stream estimate appears to be in the order of 7 mm/day in the summer months (Ministry of Agriculture, Gilat). This value can account for only 17% of water loss. It means that about 73% of the water infiltrates into the ground in the summer. The loss of the water in the summer occurs very fast; already, at the upstream of the stream before the entrance to the city of Beer-Sheva, about 50 km from Rihiya, the stream loses 80% of the water when only 10% of the water is lost due to evaporation, and 70% due to infiltration. In the upper part of the stream, there is little vegetation growth on the banks, so even in the wintertime evotranspiration by plants is minimal and for all practical purposes can be neglected. By the time the water reaches Shoket junction (where a sewage treatment plant is currently

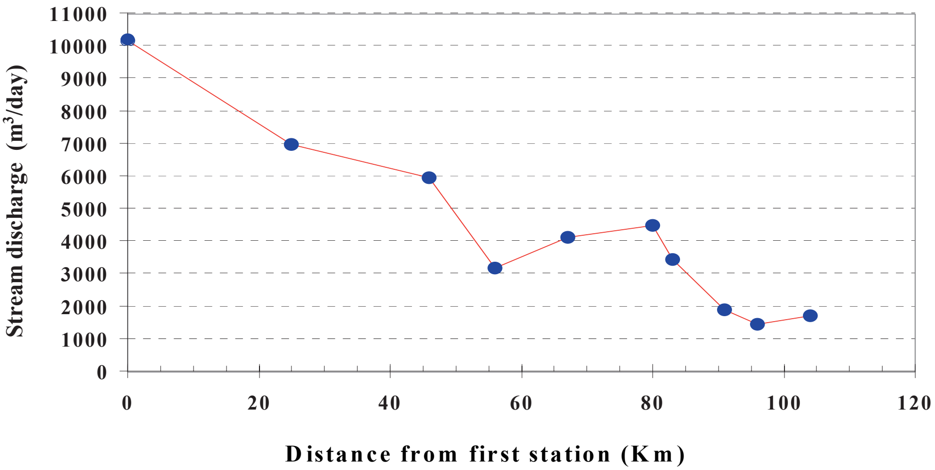

Figure 3. Base flow water discharges along the Besor Stream.

being built for the treatment of Hebron sewage), about 53% of the Hebron sewage infiltrates the ground.

3.2. CHEMICAL CHARACTERISTICS OF BASE FLOW

The base flow in the Hebron/Besor Stream was sampled and analyzed at differrent occasions. The flow in Hebron Stream, as expected, is primarily raw sewage discharged from the city of Hebron and from the marble quarries, which gives the water a whitish–grayish color. The stream flows all year long and can be divided into two segments: One from the city of Hebron to the Green Line in Israel, and the second from the Green Line to Tel-Sheva. Overall, the stream is more polluted upstream near the outlet of Hebron sewage with very high values of COD and BOD (up to 1190 and 1050, respectively; see Table 1). The organic matter in the Hebron/Besor Stream is higher than in the lower part, indicating higher levels of pollution from industrial wastewater and domestic sewage in this section. This situation is probably due to fact that the city of Hebron has a combined sewer collection system, gathering both industrial wastewater and domestic sewage – disposing it untreated into the Wadi.

The Total P and Total N are much higher in the upper part of Hebron Stream. The water running in the Hebron Stream, both on the Palestinian side and on the Israeli side is of extremely low quality and is similar in composition to the raw sewage entering the treatment plant for the city of Beer Sheva and the city of Rahat. Most of the measurements taken along the Hebron Stream fall in the range of raw sewage, while in the case of COD and BOD we can see that the values fall in the lower end of the raw sewage range. The stream does show a limited self-purification mechanism that partially treats the sewage and

TABLE 1. EC, TSS, COD, BOD and TOC values in the Hebron Stream

Hebron/Besor (Palestinian)	Hebron/Besor (Palestinian)		Hebron/Besor (Israel)	
	Range	Average	Range	Average
EC (mS/cm)	1.254–3.49	1.874	0.72–3.05	1.80
TSS (mg/L)	42–506	713	33–11234	3774
Total COD (mg/L)	240–1190	654	12.5–771	388
Total BOD (mg/L)	81.6–1050	498	13.8–272	137.43
TOC (mg/L)	97.2–386	220.2	86–223	141.3

TABLE 2. Major ions concentrations in the Hebron Stream

Major ion (mg/L)	Hebron/Besor (Palestinian)		Hebron/Besor (Israel)	
	Range	Average	Range	Average
Cl	83.6–740	240	84–654	295.9
SO_4	27.9–44.1	33	25.1–80.4	44.4
Br	0	0	0	0
HCO_3	478–730	625	216–804	597
Na	74.6–520	190	53–366	199.5
K	15.9–25.8	21	10.7–45.6	29.5
Ca	48.3–67.1	56	38.1–97.5	62.2
Mg	16.9–37.8	27	8.42–53.5	27.5
Total N	64.2–88.8	74.6	9–91	50.317
Total P	1.86–14.4	8.47	1.36–0.59	0.975
NO_3	8.98–14.0	11	0–2.18	0.66
PO_4	9.02–19.99	15	0–30.67	8.33
NH_4	54.9–105	75	17–85.2	66.0

reduces the organic load in the water (see Figures 4 and 5). Nitrification processes are also seen which are reflected in Figure 5. A sharp decrease in the ammonia level accompanied by a more moderate increase in levels of nitrate in this part of stream begin to occur only downstream from Beer Sheva.

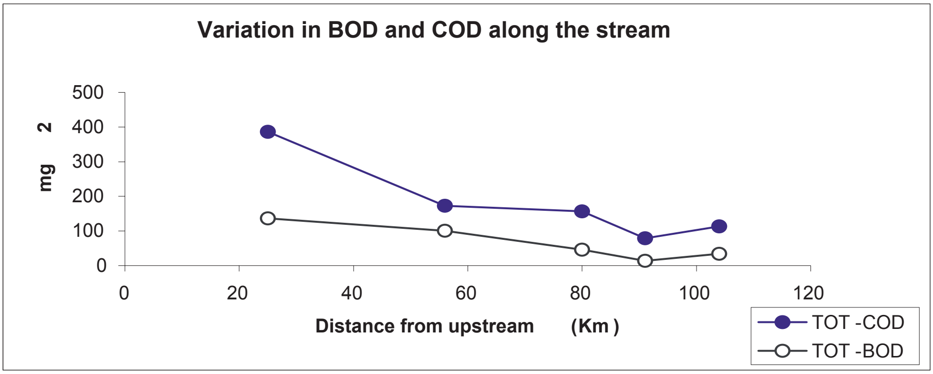

Figure 4. Variation in BOD and COD from upstream to downstream.

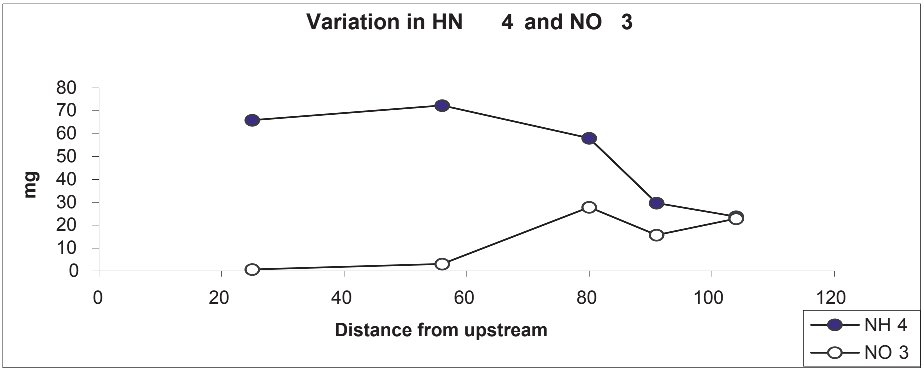

Figure 5. Variation in HN_4 and NO_3 from upstream to downstream.

The Beer Sheva stormwater drainage outlet was sampled during a local rain event (9 March 2005). The drainage outlet is adjacent to the southern industrial area of the city of Beer Sheva, next to the old city. This sample represents the urban and commercial areas' stormwater. It was characterized with lower BOD, COD, TOC, and salinity, as well as lower concentration of major ions. However, the addition of total suspended sediment is quite high and there is a small increase in concentration of some of the trace element such as: Al, 0.27 ppm; Pb, 0.0012 ppm; Sb, 0.0045 ppm; Se, 0.05 ppm; and Sn, 0.0123 ppm. This source may well be problematic especially in the beginning of the rainy season and probably contributes much to the first flush effect.

4. Conclusions

- Base flow water discharge in the Besor watershed decreases downstream by more than 80%. The majority of this loss of water may be attributed to transmission losses in the channel bed, with infiltration of pollution load into the soil and groundwater.
- The major point pollution source is raw sewage discharge from the city of Hebron into the Hebron Stream. This source changes the fundamental nature of the ephemeral stream, converting it into a de facto sewage conduit with permanent baseflow running more than a 120 km downstream.
- The Hebron Stream does show a semi-self-purification mechanism that partly treats the sewage and reduces the organic load in the water.

- A range of pollutants, including nonpoint agricultural runoff, urban stormwater, and discharge from industrial sites have also been identified at many points along the stream.
- The initial research findings about the severity and scope of stream pollution in the Hebron/Besor system confirm the operating assumption of the researchers – that progress in local river restoration requires cooperation between Israelis and Palestinians due to the transboundary nature of the surface water resources.
- Unilateral actions by either side will not return the biological integrity to the streams and may in fact involve wasted resources if there is not a coordinated effort to reduce pollution on a watershed basis. The data collected and models developed in this research underscore the urgent need for ongoing cooperation between Israel and the Palestinian Authority if the challenge posed by surface water contamination is going to be effectively addressed.

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SCENARIOS FOR A MORE SUSTAINABLE WATER MANAGEMENT IN THE DEAD SEA BASIN

RUDOLF ORTHOFER[1*], ERNST GEBETSROITHER[1], AND DAVID LEHRER[2]

[1]*ARC Systems Research, Donau-City-Str 1, A-1220 Wien, Austria*

[2]*Arava Institute for Environmental Studies, Kibbutz Ketura, P.O.Box 11, Hevel Eilot 88840, Israel*

Abstract: Following the depletion of inflows and the increased evaporation, the Dead Sea water level has fallen constantly since the 1950s. This paper discusses two scenarios for a possible future development: one follows a supply-driven approach by bringing in more water through a Red–Dead-Conduit. The second scenario assumes that more water could flow from the Lake Tiberias and the lower Jordan River, and that water usage in agriculture would be limited. Qualitative information from the narrative scenarios was translated into quantitative data to feed a system dynamic model that allows tracing the development until 2025. This paper presents three indicators for changes, namely the Dead Sea inflow–outflow balance, the Dead Sea water level, and the water uses in major usage sectors. The authors conclude that a more sustainable water management is possible: First, the mineral extracting industries must cease evaporating Dead Sea water. Second, the flow of the lower Jordan River must be restored to at least a third of its original flow. Third, if water from the Red Sea is brought into the region, there must be not only an environmental but also a social impact assessment.

Keywords: Dead Sea; Jordan River; water management; scenario; system dynamic modeling; population; water use

* To whom correspondence should be addressed. Rudolf Orthofer, ARC systems research, Donau-City-Str 1, A-1220 Wien, Austria; e-mail: rudolf.orthofer@arcs.ac.at

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1. Introduction

1.1. THE PROBLEM

The Dead Sea basin is of global and regional importance. It is a global natural and cultural heritage, and it plays a major role for regional economic development. The Dead Sea basin proper is part of greater Dead Sea watershed that also includes the Jordan Valley basin in the north and the North Arava basin in the south. The Dead Sea basin covers about 40,000 km^2 and is politically shared by Israel, Jordan, and the Palestinian administration. The Dead Sea is the terminal lake of all its inflows. In 2006, its surface has stood at 418 m below sea level. With a salinity of about 30% it is the most saline water body in the world (Raz, 1993; Gertmann, 1999). Rainfall is limited to winter months; it varies from about 500 mm/year in the northwestern highlands to less than 100 mm/year in the valley floor (Isaac et al., 2000). Potential evapotranspiration in the valley floor is about 2,000 mm/year, and actual evaporation from the Dead Sea surface is about 1,300–1,600 mm. The temperature is about 40°C in summer and 15°C in winter (Assaf et al., 1998).

Receiving only marginal rainfall the amount of water the Dead Sea contains depends on the inflows it receives. Before the 1950s the Dead Sea had received about 1,300 million cubic meters per year (MCM/year) of good quality freshwater from its major contributor, the Jordan River. Until the late 1990s, however, this amount has dropped to about 100–200 MCM/year of saline and polluted water (Hillel, 1994; Al-Weshah, 2000; Shavit et al., 2001). The reasons for this development are given in Figure 1: Israel had used nearly the entire inflow into the Lake Tiberias for use in the National Water Carrier. Similarly, Jordan has blocked the inflow from the Yarmouk to use its water for the King Abdullah Canal. In addition, several inflows from side wadis were reduced because of exploitation of their headwaters (cf. Orthofer et al., 2001). Another cause for the decline might be found in a reduced water discharge from below-surface inflows, but the interaction between enhanced groundwater abstraction in the populated western and eastern uplands and these underground springs are not yet understood.

Following the depletion of inflows and the increased evaporation, the Dead Sea levels have fallen constantly since the 1950s, and in 1978 – after falling below the –400 m level – the Dead Sea had retreated from its shallow southern basin. Since then the southern basin consists only of man-made evaporation ponds, to which a net amount of about 200–250 MCM/year is pumped from the northern basin for exploiting the minerals (Gavrielli et al., 2002). It is estimated that the salt industries contribute 25–30% of the present total evaporation rates. Figure 2 shows the accelerating decline of the water level since 1976 according to the Israel Hydrological Service. The surface of the water body that before 1950

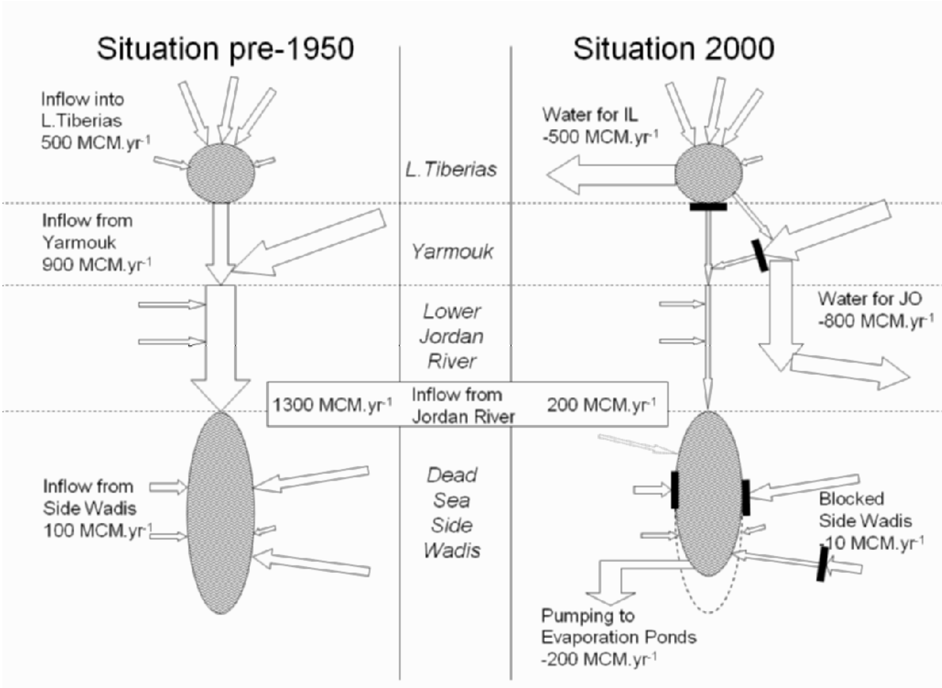

Figure 1. Water flows in the Jordan Valley and Dead Sea basin pre-1950 and changes until the year 2000.

has been about 1,000 km^2 has shrunk currently to about 650 km^2 (Eidelman et al., 2006).

At the same time as there is a decreasing water table in the northern basin, there is an increasing water level in the southern evaporation ponds. This striking discrepancy is caused by the slow but constant siltation of evaporation ponds (Raz, 2005).

The decline of the water level of the Dead Sea in its northern basin is the obvious and easily visible symptom of the degradation. However, there are less visible consequences as well, most notorious the sinkhole that have developed along the shores. Sinkholes are rapidly developing caverns (with 3–10 m diameter and a depth of up to 10 m) that have already caused major infrastructural damage on roads, bridges, buildings, etc. Sinkholes are caused by lowered water tables and groundwater overexploitation (Bowman et al., 2000; Baer et al., 2002). Furthermore, as result of the lowering of the water level, the adjacent aquifers are seriously affected. Furthermore, the decline of the Dead Sea also affects the freshwater springs on its shores (e.g. Ain Fashkha, Ain Ain Turiba) that support a unique biodiversity. The decline of the water level has also already had a serious effect on tourism.

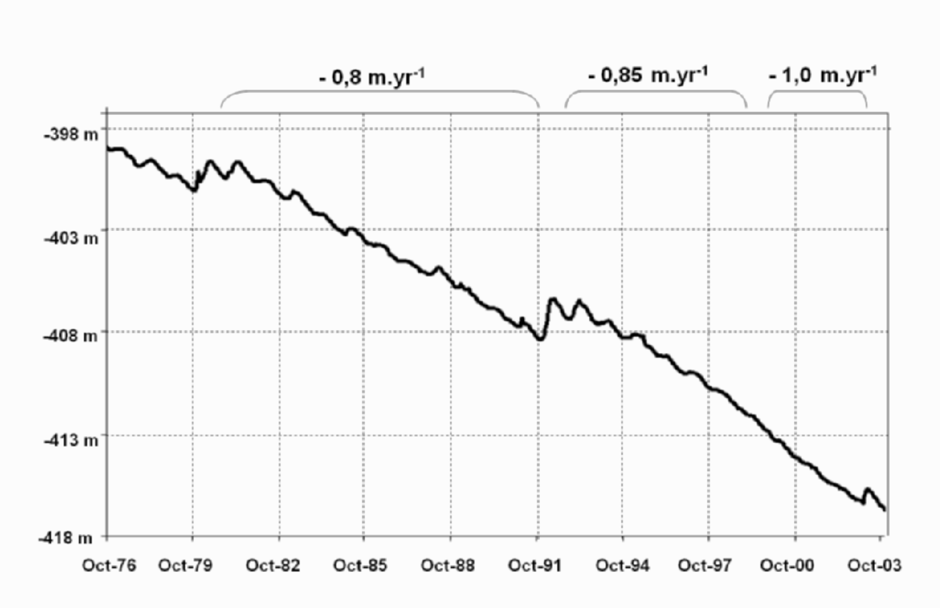

Figure 2. Decline of the Dead Sea water level between 1976 and 2003 (Data taken from Israeli Hydrological Service).

The costs of the degradation are substantial: tourism facilities can only helplessly look upon disappearing shorelines. Sinkholes have already cost major repair expenses on the more developed Israeli shores; the looming danger of more sinkholes discourages further investment. Planning and development has come to a stand still and has Israeli government and local leaders scrambling to find a technical solution to the sinkhole phenomenon. There is a strong disagreement with between the local residents and the Ministries of the Environment and Infrastructure regarding the most appropriate strategy for development in the region due to the sinking Dead Sea and the resultant sinkholes. One of the main problems with sinkholes is that they are currently unpredictable and thus often large areas have to be closed for agriculture or tourism. The increasing water table at the southern evaporation ponds requires protection of the tourism facilities through costly dams.

1.2. PROJECTING FUTURE DEVELOPMENT

This paper summarizes a few results from an interdisciplinary study done by an international team with Austrian, Israeli, Jordanian, Palestinian, and UK scientists. It was hoped that collaboration of engineers with social scientists would help to analyze the driving forces of the decline of the Dead Sea water usage system and to outline options for a more sustainable water management. It is clear that any solution will not only have to rely on a sound physical basis, but will have to ensure social equity through the region. The study area is outlined in Figure 3. While the western side study areas follows the watersheds of the sub-basins, the eastern (Jordanian) side of the study area has been cut off at the 250 m elevation line. This was necessary because on the Jordanian side the Wala, Mujib, and Haza subbasins stretch vastly into eastern Jordan which has made it difficult to collect the base data. Following that, the population distribution has a marked shift toward the Palestinian part of the study areas in the northwest with many people living the urban habitations in the mountains; these are physically part of the Dead Sea basin, but *de facto* part of a different social and economic system.

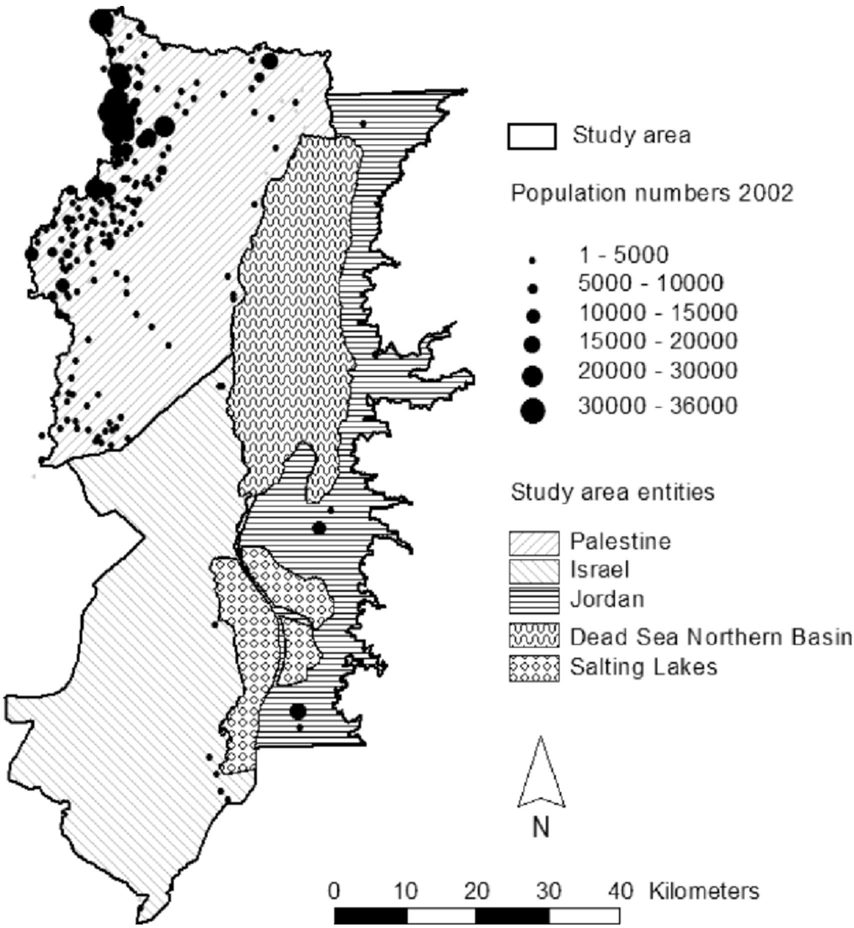

Figure 3. The Dead Sea study area.

The physical goal for stabilizing the Dead Sea water level in the long term is fairly well known: in order to prevent further degradation of the Dead Sea and to ensure at least its current water table, it needs a net water inflow of about 600–1,000 MCM/year (Gavrielli et al., 2002). More inflow may be conducted through two options.

One option is to (at least partially) restore the flow of the River Jordan to around 450 MCM/year, which has been found to be a realistic possibility in a previous study (Orthofer et al., 2001). The stopping of the evaporation by mineral works would provide an additional 200–250 MCM/year. A major problem for this option is that "economically valuable" water (that could be used for the urban sector, for agriculture and industrial development) is being discharged into the Dead Sea, where it becomes immediately "economically useless." As long as water is considered a commodity, some politicians in the region consider it necessary that someone pays this bill that could be estimated at about $45 million.

The second option is currently discussed at global level: pumping about 1,800 MCM/year sea water through a 240 km long conduit from the Red Sea to replenish the missing inflow, to use the gravity pressure for desalination through reverse osmosis, and to produce electricity. The project would generate about 800 MCM/year desalinated water while the remaining 1,000 MCM/year of brine would be dumped into the Dead Sea. This "solution" is a large centrally controlled investment of about $50,000–10,000 million. It is targeted at providing additional freshwater for the urban sector Jordan rather than at preserving the Dead Sea. There are a number of negative impacts that are expected, including an unsustainable regional social development because of "new water riches" and environmental problems associated with the change of the elemental composition of the Dead Sea water that may lead to algae blooming (Gavrielli et al., 2002) and temporary precipitation of gypsum.

In this paper we will present two options for a future development. First, we summarize the narrative scenarios that were discussed with focus groups. The qualitative information of these scenarios was translated into quantitative and semiquantitative data. A system dynamic model was established that allows tracing the development over time. Of the many model components, only a few key indicators were selected to demonstrate similarities and differences of the two scenarios. Of course, our quantitative model can only reflect the quantitative (essentially physical) dimensions of the consequences of development options. Qualitative impacts – such as changes of traditions, perceptions, or a development toward more of less equity are necessarily omitted in this simulation.

This paper focuses on three indicators, namely, the Dead Sea inflow–outflow balance, the Dead Sea water level, and the water used in the different user sectors.

2. Development Scenarios

2.1. CHANCES AND LIMITATIONS OF SCENARIOS

Narrative scenarios are “an attractive alternative to the false precision promised by point-estimate forecasts” (Schnaars, 2001) because their qualitative nature is often more appropriate in thinking about the future than quantitative methods.

We chose to use scenario development as a way to outline possible futures of the Dead Sea basin that would allow looking past our own blind spots and seeing alternative solutions that were not being discussed before. The advantage of this approach is the ability to create multiple futures under different sets of assumptions. Thus we refrained from deciding which future was the “most likely,” but focused on outlining which futures were “possible” and had relevance for decisions being made today. This gives a more integrative view of the possible futures without falling into the trap of trying to predict specific outcomes 20 or 25 years into the future.

Following the methods suggested by Schwartz (1996), Kleiner (1999), and we have defined driving forces that have a major impact on the system, that are independent of each other (uncorrelated), and that are highly uncertain. With these requirements, we have identified three driving forces, each one of them with two options:

- The level of cooperation – “high” or “low”
- The role of agriculture – “central” or “limited”
- The type of investment – “high impact” or “low impact”

These three driving forces allow the establishment of eight possible scenarios. This paper focuses on only two of them, both optimistically assume a “high” level of cooperation among the riparian countries, and thus a steady regional economic and political development. The two scenarios differ in the role that agriculture will play in the future and in the type of investment (which reflects the water management strategy) that is being used.

Both scenarios refer to the period 2000–2025. While being far from “realistic” the two scenarios are instructive in terms of looking for a more sustainable than today solution to the problems of the Dead Sea basin because they represent very different approaches.

2.2. FRAMEWORK FOR SOLUTIONS

In order to a "more sustainable than today" water management option we have assumed a peaceful future in the regions. Thus both scenarios rely on a "high level of cooperation" and assume that the current political turmoil would come to an end, and with the help of the international community lead to a more stable political situation for the region. In mid-2006 – at the time of the writing of this paper – Israel, Lebanon, and the Palestinians are involved in armed conflict in Gaza and in southern Lebanon, and the current situation indicates a possible continuation of a low level of cooperation. However, the purpose of scenario development is not to predict the future but to help understand how present decisions and policies might affect the future. Therefore in understanding which policies might lead to sustainability in the region, scenarios that depict high levels of cooperation in the future are extremely relevant even if today's headlines make them seem far from reality. Table 1 summarizes the driving force indicators for the two scenarios presented in this paper.

TABLE 1. Driving forces of the two scenarios

	"Supply-driven" scenario	"demand-managed" scenario
Level of cooperation	High	High
Role of agriculture	Central	Limited
Type of investment	High impact	Low impact

One scenario assumes that agriculture will continue to play a central role in the economies and social frameworks of the Dead Sea riparians. Farmers will continue to receive political support and therefore water will remain cheap and in high demand. The answer to this high demand for water in the region is to invest in capital, intensive high impact new water projects such as the Red–Dead conveyance system. In effect this scenario translates into "bringing in much more water from the south and trying to find users". Thus we have named this the "supply-driven" scenario. In a system view, such management solutions bear the inherent danger that increased supply often leads to further increased demand.

The second scenario assumes that agriculture's role will be diminished in the region due to changing political attitudes and shifting consumer demand. Price supports for water will be reduced raising the price and reducing the demand for water by farmers. Farmers will look for alternative agriculture, which provides a higher ratio of income per cubic meter of water. The technological solutions offered in this scenario are low impact such as wastewater recycling and the usage of plants that are water efficient tolerant to lower-quality water, but it is also assumed that a series of seawater desalination plant along the Mediterranean Coast will play an important role. The bottom line of this scenario is "allowing more water to flow from the north and trying to minimize usage for irrigation". Thus we have named this the "demand-managed" scenario.

These two scenarios are useful because they point to two extremely different approaches to water management: bringing additional supplies of water to satisfy the demand vs. reducing the demand for water to match the available supplies.

When discussing alternative solutions to the problems facing the Dead Sea basin including not only the declining level in the Dead Sea surface but also the degraded situation of the Jordan River, the response to the possibility of allowing water to flow back through the Jordan River to replenish the Dead Sea was always met with the same reaction: "Where will you get water to replace the water from the Jordan River sources?" The scenario development processes allowed the research team and eventually stakeholders and policy makers to look past their blind spots and see that there are other alternatives to finding more water such as reducing the amount of water being demanded. Exploring the "demand-managed basin" scenario allows people to question assumptions about water use in the region. On the other hand, considering the seriousness of the water deficit in the region, especially in Jordan and the growing needs of the region with the potential for an independent Palestinians state on the horizon, there is no "clear" and "obvious" solution for the water needs of the population. Realistic solutions will likely need to consist of a combination of demand and supply management of water and water-related land management.

2.3. SCENARIO ASSUMPTIONS

2.3.1. Assumptions for both Scenarios

By 2025, following peace agreements with Israel, Palestinians will independently govern its own territory including the northwestern shores of the Dead Sea according to the pre-1967 boundaries. Israel, Jordan, and Palestine will have created a joint water authority for a basin-wide water management.

By the year 2025, the three riparian nations around the Dead Sea will have strong economies, and stable political environments. With its warm climate and the proximity to the European market, the area has become attractive to international investors. Tourism and agriculture are the two main destinations of international capital. There was a very rapid economic development particularly in the new Palestinian state, which has resulted in a more equitable water distribution to the Palestinian population and a general economic recovery of the overall state. The Dead Sea basin has become a focus for building large hotels and resorts aimed at the European market while all three nations are supplying fresh fruits and vegetables to European markets.

2.3.2. Assumptions for the "Supply-Driven" Scenario

As water was considered the key to continued economic progress in the region, large water projects have been a priority for both government and private investment.

By 2008, in order to provide the necessary water, the three governments have agreed on a $10,000 million investment of the Red–Dead water conveyance system ("Peace Conduit"). This system has been operational from 2012, and since then provides large amounts of drinking quality water to the urban centers (mainly in Jordan) and for local agricultural usage. Despite the increase of water availability, the need for water has continued to grow because of the rapid development of the region. Israel and Palestine were working together to successfully increase their water supplies through large desalination projects of seawater and brackish water, dams in every available wadi and wastewater recycling. More than half of the water that is pumped through the "Peace Conduit" is disposed of at the southern shores of the Dead Sea as desalination brine; this leads to an increase of the water levels, but also to possible environmental problems.

Throughout the scenario period, agriculture has been a major focus of national policy making, particularly in Jordan and Palestine. The physical environment and the ready availability of water have made the Dead Sea basin a perfect location for newly established large agrobusiness enterprises that target the European market. Insofar governments have continued to make accessible sufficient amounts and sufficiently cheap water to farmers.

Both the Israeli and the Jordanian mineral industry will start to reduce their activities at about 2015 for economic and environmental reasons and close 2020. Many industrial jobs will have been lost: Jordanian workers that live in the region have turned to agriculture and the upcoming service sector. Israeli workers who live mostly outside the basin have found jobs elsewhere. As the southern evaporations ponds have slowly turned into salt flats, Israeli tourism facilities in the south have closed down. Mixing Dead Sea water with the brine from desalination has cause aesthetic problems near the location of the inflow.

By 2015, when the surface level of the Dead Sea has shown signs of a slow recovery, Israeli capital has supported the establishment of a Palestinian tourism stronghold at the northern end of the Dead Sea. Throughout the scenario period, the Jordan River continues discharging only small amounts of polluted and saline water. Any possible increase of the outflow of the Lake Tiberias will have been used by Palestinians for their economic recovery, mostly for food production (irrigation, livestock, and fishponds).

By 2025, rapid economic growth, large water projects, and the development of large tracts of land for agriculture have been changing the face of the region. Some of the pristine deserts have been transformed into irrigated land and tourism resorts. The agricultural area is almost fourfold compared to 2005. The few remaining nature reserves along mountain wadis and along the shores of the Dead Sea will have dried up. While the benefits of peace and development are clear, many people have been disturbed by the loss of much of the natural beauty and ecological systems.

2.3.3. Assumptions for the "Demand-Managed" Scenario

The major difference to the "supply-driven" scenario is that in this scenario it is assumed that agriculture will be limited according to available water (mainly reused wastewater) and that – instead of the Read Dead Conduit – a series of smaller technical investments will be made to supply water to the arid basin.

Following the favorable economic conditions that are a result of the high level of cooperation, water remains a critical factor for regional development. The overall strategy to overcome this is a slow shift from irrigated agriculture of bulk crops with fresh water toward irrigation of water-efficient crops with wastewater, and the application of a low-impact water management.

By 2025, agriculture will have only a limited economic and social role in all three countries. The trend away from agriculture has started in Israel already during the early 1990s with Jordan following during 2005–2010. In Palestine, agriculture has continued to play a major role for the economy, particularly for the rural population until about 2015. After then, with the economy shifting toward the service sector, the role of bulk agricultural production has been reduced for Palestine as well. By 2025, remaining agriculture in Jordan and Palestine has been centered on high-value efficient crops that fit into the dry climate (such as cactus, date, figs, pithaya, medicinal plants). Focus of Israeli agricultural development has been shifted more toward the Negev, thus competing less with Jordan and Palestine for water in the Dead Sea basin. Agriculture in Israel and Jordan has been influenced by a high demand for locally grown organic produce at higher prices.

Since 2005, water has gradually been sold at market value for its respective water quality with the price of drinking water determined by its value for the urban sector. Recycled wastewater has become widely available and inexpensive, because costs for reclaiming this water are covered by the urban producers of wastewater. Not all farmers have been able to make the adjustment toward the high-efficiency crops resulting in smaller number of farms and smaller water use. In Jordan, there has been a marked shift of labor from agriculture to industry and services.

By 2025, no more fresh water will be used for agriculture in Israel. In the other countries, some fresh water will be occasionally used, about 45% irrigation water comes from recycled wastewater. In Palestine, where in 2005 much of the irrigation is still based on furrow methods, by 2025 drip irrigation will be widely used.

Plans for Red–Dead Conduit have been abandoned in 2008 by all countries because it was found that economically it would not be feasible, particularly considering the need for protection of the environment and ensuring the functioning of the regional social fabric. Thus, instead of financing the conduit, the World Bank will have helped the three countries to come up with a plan to relieve water stress which includes wastewater recycling, improved efficiency of water delivery systems to prevent water loss, and rainwater harvesting. By 2010–2015, a series of sea water desalination plants along the Mediterranean Coast will have been built that provide abundant of quality fresh water at costs that are appropriate for the urban sector.

This additional source has allowed Israel to reduce the pumpage from Lake Tiberias, thus partly restoring the flow of the River Jordan. By 2025, Israel gets one-third of the total water consumption from wastewater recycling, desalination, and from aquifers and rainwater harvesting.

With the help of the international community, part of the Israeli desalination water goes to Palestinians, who then have available desalination water and groundwater from eastern and northeastern mountain aquifers. Jordan gets one-fourth of their water from the Lake Tiberias and the rest from desalination plants in Israel, wastewater recycling and local aquifers.

Through these measures, starting from 2010, the Jordan River is partly restored with flows of water in a quality that may support the riverine ecosystems.

The trend toward sustainable agriculture and sustainable tourism (decentralized tourism) develops around the Dead Sea. This means less amount of high-quality freshwater is used for tourism and a shift from luxury tourism with high water consumption per tourist to a more sustainable tourism occurs. The development of research and biotechnology at the Dead Sea replaces some agriculture. The Dead Sea factories are exploring ways to redesign their basic mission to lower their environmental impact. In any case this means that they will stop to pump water from the Dead Sea for producing minerals.

3. Impacts

We have “translated” the qualitative scenario assumptions into a quantitative schematic by establishing a system dynamic model that links the development of driving forces to quantitative indicators. The “translation” was based on empirical data, statistical relations, and assumptions. We have chosen the system dynamic modeling method because it is a method that allows to combine quail-tative causal relationships ("if…then…because") with quantitative indicators "lookup tables"). Details of the modeling methods were published elsewhere (Gebetsroither, 2006; Gebetsroither and Loibl, 2006; Loibl et al., 2006).

Of course, all results have a high degree of uncertainty. This fact is not only caused by the inherent uncertainty of the scenario assumptions: scenarios are never certain but in essence arbitrary. Uncertainties also stem from unknown quantitative relations of indicators, such as the relation of Dead Sea water levels with abundance of adjacent groundwater, or the relation of wastewater prices with competitiveness of irrigated crops in an international market, etc.

However, the purpose of the system model is not to result in a certainty of numbers, but much more to indicate possible trends. Thus we will focus here on a few indicators that identify such future trends in the region, naturally such indicators that many consider as status indicators of the region: the inflow–outflow balance of the Dead Sea, the Dead Sea water level, and the water use for different usage sectors.

3.1. TRENDS IN BOTH SCENARIOS

In line with the scenario assumption of a high level of cooperation it is projected that the population in the Dead Sea basin will increase. This is mostly the case for the Palestinian population (in the Palestinian part of the study area) which comprises the densely populated areas in the mountains in the west (with parts of Jerusalem, Bethlehem, etc.).

Following the high level of cooperation and the peace agreements it is projected that a large number of former Palestinian refugees will settle in the Palestinian urban areas in the mountains and around Jericho. In total, the Palestinian population could grow from 0.6 million in 2005 to 1.7 million in 2025. Paralleling the Palestinian population growth, many of the 170,000 Israelis that currently live in the occupied Palestinian study area ("settlers") are projected to relocate to Israel proper and thus their number is expected to decrease to about 50,000 by 2025. This high net population growth in the Palestinian part of the study area will leads to a very high growth of drinking water consumption that needs to be satisfied. The source of this water will be different in the two scenarios, but the order of magnitude of the demand will be about the same. The trends with the Israeli population and the Jordanian population are slightly different (+/–2%) in both scenarios, but these do not significantly influence the overall development trends (Table 2).

TABLE 2. Population in the study area (numbers rounded to 2 significant digits)

Year	Palestinians	Israelis in Israel	Israeli “Settlers” in Palestine	Jordanians	Total
2005	510,000	2,000	170,000	40,000	720,000
2010	620,000	4,000	160,000	45,000	820,000
2015	750,000	5,000	140,000	53,000	940,000
2020	1,100,000	5,000	90,000	63,000	1,250,000
2025	1,700,000	5,000	50,000	75,000	1,800,000

Both scenarios project that the evaporation industry in the southern ponds will reduce their activities after 2015 and stop by 2020, the pumping of Dead Sea water to the southern basin will be reduced from its present level of 250 MCM/year to 160 MCM/year in 2015, and to zero by 2020 and thereafter. This will have major consequences for the southern basin. Termination of pumping water will of course be beneficial to the overall water balance of the Dead Sea. On the other hand, this termination of pumping water will mean that the southern basin will start to dry up leaving behind salt-laden dust flats. The environmental consequences of such a development are still not fully investigated: it might well be that windblown saline dusts harm the soils in the regions and thus affect negatively the agricultural activities. Besides the problems with dusts and the unpleasant visual environment, tourism establishments in the southern basin at Ein Boqeq will also not have access to Dead Sea water any more which is currently their only attraction.

3.2. TRENDS IN SUPPLY-DRIVEN SCENARIO

The supply-driven scenario assumes that from the year 2014 the Red–Dead Conduit will bring new water into the region. Of the 1,800 MCM/year pumped from the Red Sea, about 800 MCM/year will be desalinated to yield drinking quality water, mostly this will be “exported” for urban use in the densely populated urban centers in the uplands, but about 200 MCM/year will also be available for local use. The remaining desalination brine – about 1,000 MCM/year – will be dumped into the Dead Sea at its southern end.

This means that the inflow–outflow balance of the Dead Sea is projected to change quickly after 2014. In addition to the inflow of desalination brine, there is also less outflow after the phaseout of the evaporation industry during 2015 and 2020. Thus the current water deficit of more than –550 MCM/year will decrease steadily to yield a positive balance of about +900 MCM/year by the year 2020 and thereafter (see Figure 4); the slight decline of the balance after 2020 is caused by additional water usage due to the continuing population growth.

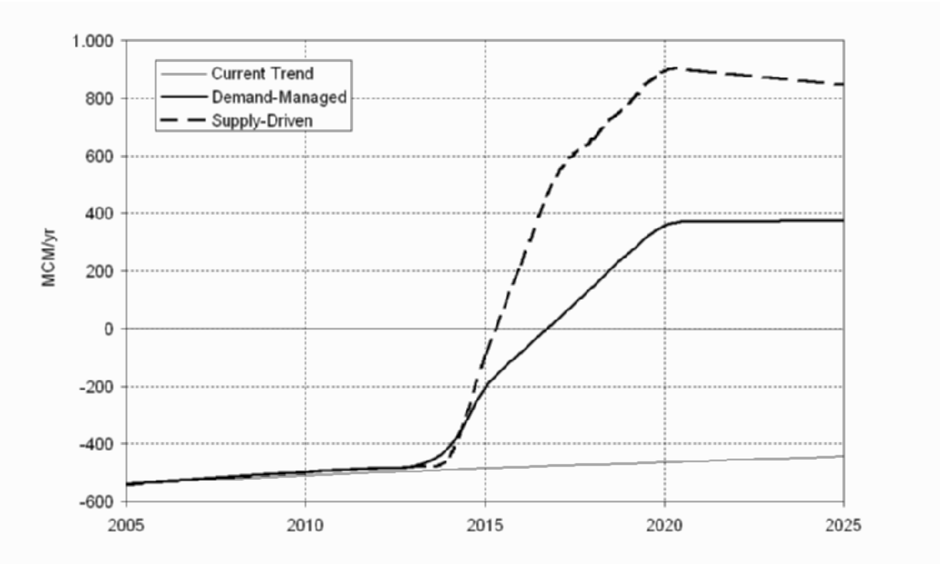

Figure 4. Development of inflow–outflow balance of the Dead Sea from 2005 to 2025 in both scenarios. "Current trend" data are given for visual comparison only.

The visual result of the changing water balance is the water level. It is projected that the water level will continue to fall currently from about –417 m to a level of –425 m during 2015–2016 (Figure 5). After that, the water level could recover slowly to about –415 m by the year 2025 – which is about the same level as in the year 2000–2001. This also means that by 2025 the water level will still be far from the –398 m level that was observed before 1975 when the Dead Sea was also covering the southern basin – and which is considered a natural state of the Dead Sea system.

While the overall trend of population in the study area is about similar in both scenarios, there are some differences in the three parts of the study area. The Israeli population that lives in the Israeli proper is projected to remain at 2005 levels, while the Jordanian population will grow from 40,000 in 2005 to around 70,000 in 2025. Both these developments, however, are overshadowed by the projected high net increase of the population in the Palestinian study

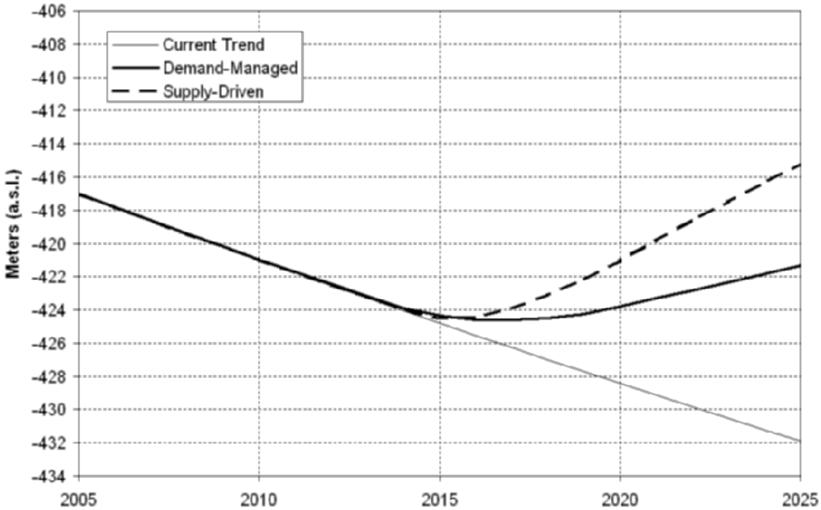

Figure 5. Development of surface water level of the Dead Sea between 2005 and 2025 in both scenarios. “Current trend” data are given for visual comparison only.

area. Total population is expected to almost triple between 2005 and 2025, which lead to considerable demand for urban water.

Figure 6 shows the trends of water use in the region for different usage sectors and all water qualities (drinking water, slightly brackish water, and reused wastewater) except Dead Sea water that is used for evaporation in the southern ponds. In total, this water use is expected to grow from 130 MCM/year in 2005 to 380 MCM/year in 2025. If only drinking water is considered, the relative growth is even higher with a more than fourfold increase from 70 MCM/year in 2005 to 300 MCM in 2025.

The highest growth rates come from the urban sector. Usage of drinking water for the urban sector is projected to increase from about 40 MCM/year in 2005 to 120 MCM/year in 2015, and to 220 MCM/year by 2025. In terms of per capita water availability this indicates an increase from 55 m^3/capita in 2005 to 110 m^3/capita in 2015 and 120 m^3/capita in 2025. Almost 80% of this urban consumption should be recoverable as wastewater and could be reclaimed for further use, e.g. in agriculture. However, we foresee that during the overall projection period only 2 MCM/year are being actually used. This reflects the fact that abundant freshwater from the Red–Dead Conduit will be available and there would be no pressure to use wastewater.

In agriculture, there is also a marked growth of freshwater use, namely from about 45 MCM/year in 2005 to 80 MCM in 2015 and almost 130 MCM/year in 2025. It is striking that because of the availability of quality freshwater, and

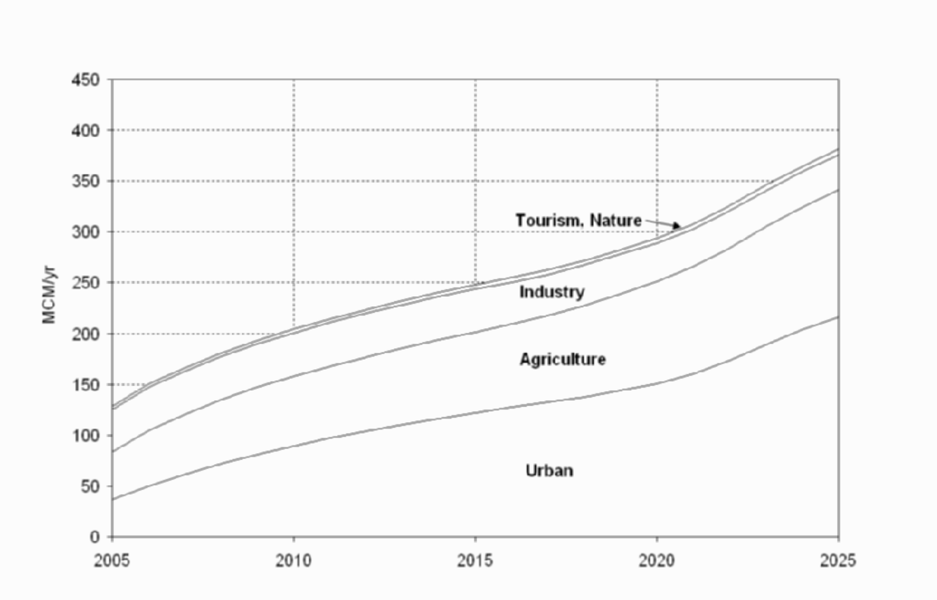

Figure 6. Trends of water use by sectors between 2005 and 2025 in the supply-driven scenario.

because of the continuing subsidies of water, more than 50% of all water used in agriculture are projected to consist of drinking quality freshwater.

In industry – as mentioned before the 250 MCM/year of Dead Sea water that is used for evaporation are excluded – water use (freshwater and brackish water) will remain similar at about 40–45 MCM/year during the period from 2005 to 2014, but will be reduced slowly to about 35 MCM/year until 2025. This reflects the assumption that after the phaseout of the evaporation mineral works other industrial activities (such as food industry or stone quarries) would start to operate. However, only very little of the water would be of drinking water quality, while about 90% of this water would be of lower grade quality.

Compared to the urban and agricultural sectors, water use for tourism will remain relatively small. Nevertheless, the projected consumption will double from about 2.5 MCM/year in 2005 to more than 5 MCM/year by 2025. The share of drinking water that is currently at around 80% is expected to increase to about 90% because of the expected development of luxury resorts.

3.3. TRENDS IN DEMAND-MANAGED SCENARIO

The demand-managed scenario assumes by 2010–2015, Israel will have a series of sea water desalination plants along the Mediterranean Coast that provide 2,000 MCM/year of quality freshwater. This additional source allows Israel to reduce the pumpage from Lake Tiberias initially by 400 MCM/year, and to reduce the unilateral exploitation of the eastern and northeastern mountain aquifers. Thus the flow of the river Jordan will be partly restored. It is projected that the Jordan river flow will slowly increase from 200 MCM/year in the 2005–2013 period to about 800 MCM/year by 2020 and thereafter. Furthermore, with the help of the international community, part of the Israeli desalination water will be available for the Palestinian urban consumption. In total, Palestinians will have available about 800 MCM/year from the desalination and from their access to eastern and northeastern mountain aquifers.

The inflow–outflow balance of the Dead Sea will change following the phaseout of the evaporation industry (starting 2014) and the additional input of water from the Jordan River. Thus the current water deficit of –550 MCM/year will decrease steadily starting in 2014 to a value of 400 MCM/year in the year 2020 and thereafter (Figure 4).

The effect on the water level, however, is much lower (Figure 5): the water level that is expected to fall to about –425 m by 2015 will stabilize at this level until about 2018 and recover only slowly afterwards. It is projected that it will reach no more than –419 m by the year 2025. This means that under the scenario assumptions the Dead Sea will not reach the –400 m level that is necessary to naturally flow into the southern basin. Thus, when the Dead Sea works stop pumping water into the southern basin by 2014, the southern basin will dry up and form a "dust bowl" of saline sediments.

While the overall trend of population in the study area is about similar in both scenarios, there are some differences in the three parts of the study area. The Israeli population that lives in the Israeli proper is projected to more than double from the 2005 levels, yet the number remains very low anyway.

Similarly, the Jordanian population will double from 40,000 in 2005 to around 80,000 in 2025. The dominant factor of population growth is the high net increase of the population in the Palestinian study area (see above). The total population of the study is expected to almost triple between 2005 and 2025, which lead to a considerable demand for urban water.

Figure 7 shows the trends of water use in the region. This figure summarizes drinking water, slightly brackish water, and reused wastewater; as in the previous scenario, water that is pumped from the Dead Sea for evaporation in the southern ponds has been excluded. Although the total water consumption in 2025 is about 30% lower than in the "supply-driven" scenario, there is a considerable increase in water consumption: water use is expected to double from 130 MCM/year in 2005 to 270 MCM/year in 2025. If only drinking quality freshwater is considered, we project a threefold increase from 70 MCM/year in 2005 to about 210 MCM/year in 2025.

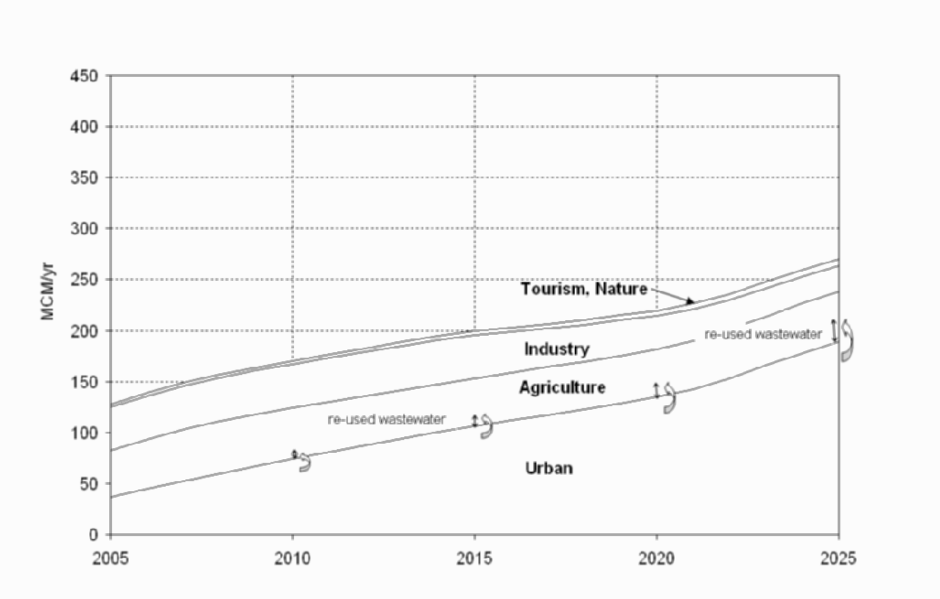

Figure 7. Trends of water use by sectors between 2005 and 2025 in the demand-managed scenario.

The growth in total consumption comes mainly from the projected population growth in the urban sector. The share of the urban sector that is estimated to be around 30% of total water consumption in 2005 will grow to 50% by 2015, and 70% by 2025. Usage of drinking water in the urban sector will increase from about 35 MCM/year in the year 2005 to 120 MCM/year in 2015, and to 190 MCM/year in 2025, which is a more than fivefold increase. The per capita water availability that is around 55 m^3/capita in 2005 will increase to 125 m^3/capita in 2015 and then fall slightly to a reasonable level of about 100 m^3/capita in 2025.

The high consumption of water in the urban sector yields much wastewater; it is estimated that by 2015 almost 100 MCM/year and in 2025 almost 140 MCM/year of wastewater could be collected and reused. However, due to the prevalent reluctance of that use for agricultural irrigation, we project that only a fraction of this potential will be realized for agricultural irrigation, namely about 11 MCM/year by 2015 and 22 MCM/year by 2025. This – of course – is a tremendous increase of the current 2 MCM/year, but it fails to make full use of the potential.

Water consumption in agriculture will remain around 50 MCM/year throughout the projection period, but the composition of this water will change: while in 2005 about 25 MCM/year were fresh water, this quality will gradually decrease to about only 13 MCM/year in 2025. The freshwater used in agriculture will be used only for valuable crops – or in areas where there is sufficient freshwater that will not be used otherwise. The use of recycled wastewater for agricultural use will grow from a share of only 4% in 2005 to more than 45% in 2025.

In industry freshwater and brackish water use will remain similar at about 40–45 MCM/year during the period from 2005 to 2014, but will be reduced to about 25 MCM/year until 2025. If only the drinking quality water is considered, the reduction is even more pronounced: while in 2005 industry is using about 5 MCM/year of drinking water until 2014, this usage will be around only 1 MCM/year in 2025.

The development of water use in tourism shows a similar trend than in the supply-driven scenario, only slightly lower. As amounts of water used by tourism are very small, the overall contribution of this sector is negligible in both scenarios. The share of drinking water of the overall water use in tourism is expected to remain at around 80% throughout the projection period.

The demand-managed scenario also considers explicitly the need for allocation some water to maintain valuable ecosystems along the Dead Sea shores. Here we project a fourfold increase of allocation of freshwater, which is currently below 0.5 MCM/year to about 2 MCM/year in 2015.

4. Conclusions

The case of the disappearing Dead Sea is an example of large-scale non-sustainable exploitation of water resources with unforeseen consequences. First and foremost, the decline is a direct consequence of the declining freshwater input: this includes decreasing discharge from the River Jordan, increasing water use from natural springs and side wadis, and extensive use of aquifers that provide secondary water input (Assaf et al., 1998). Of all these factors, the River Jordan plays probably the biggest role. Insofar the Dead Sea's steady disappearance is a direct result of the water management strategies of the River Jordan riparians. The main reason for this decline is that water from the Upper Jordan River as well as water from the Lower Jordan River tributaries (e.g. Yarmouk, Zarqa) has been blocked and diverted for urban and agricultural uses inside and outside the watershed. The two most important causes are the utilization of the water from the Lake Tiberias and from the River Yarmouk, both of which used to feed the Jordan River. Water from the Lake Tiberias was pumped from 1964 to supply the Israeli Water Carrier – and most of it was used for agricultural irrigation. Similarly, water from the River Yarmouk is used to feed the Jordanian water system through the King Abdallah Canal, with much of it being used by irrigated agriculture as well.

Aggravating the problem, the Dead Sea also suffers from the forced evaporation of Dead Sea water by the Israeli and Jordanian mineral industry in the southern evaporation ponds. All-in-all, the current water deficit of the Dead Sea is about 550 MCM/year, which causes a decline in the water level of about 1 m/year.

The current outlook for the Dead Sea is bleak: the rapidly growing population in all three countries will increase the pressure for the very little remaining freshwater that currently remains unused. The projected resettlement of returning Palestinian refugees will also increase demand on the Palestinian side, which presently has no access to the water from the River Jordan. The Palestinian request for a regional water agreement is that more water should be allowed for the lower Jordan River, so that this additional water should be usable for the Palestinian population. This, of course, means that the Dead Sea would not benefit.

Over the next few years, there are plans for the further tourism and Industrial development of the area; since late 1990s there have been about 50,000 proposals for tourism projects (Meunier, 1999). In all three riparian countries, development policies have disregarded impacts on the environment, indigenous people, and small farmers. Essential water needs for nature were neglected; policies lacked incentives to promote local forms of environmental security and equitable access to natural goods and services. Water is increasingly allocated to the urban sector and to large-scale agriculture on the expense of the needs and rights of the rural and indigenous people. Consequently, the rural poor and indigenous will not have any choices but overexploiting land resources to sustain their livelihoods.

In the long run, the blocking of natural inflows will have disastrous effects on the economic, social, and environmental resources of the system, until, eventually, tourism and industry will lose their potential in the area.

The declining Dead Sea undermines the potential as a tourist destination, despite the enormous investment in hotel and resort infrastructures in Israel and in Jordan. For the fledgling Palestinian economy, the present state of the Dead Sea suggests that it may never have the opportunity to develop what should have been one of its more attractive tourist locations that could provide critical employment to a growing workforce. Most of all, the decline of the Dead Sea raises ethical issues regarding water resources at the expense of the natural heritage in the future. Many would argue that it represents an intolerable violation of the rights of future generations.

Although there is serious concern in the region about the threat of a disappearing Dead Sea, the political complexity of the current water usage patterns and the interactions of water use with the economical and social system prevent progress.

Most of the options for solving the environmental and economical problems focus on the provision of “new water from outside”. This “supply-driven” approach led to revival of an old idea for a canal between the Red Sea and the Dead Sea ("Red–Dead Conduit").

It is clear that simply bringing in "new water from the outside" cannot be considered a "sustainable" solution as long as there are no measures to limit the growing wishes for always more water; such a solution will mainly maintain current unsustainable water usage patterns. The results from the system dynamic modeling show that additional water availability will always cause more water wishes (Figure 8), and therefore the negative system feedback through "unfulfilled wishes" will be disabled.

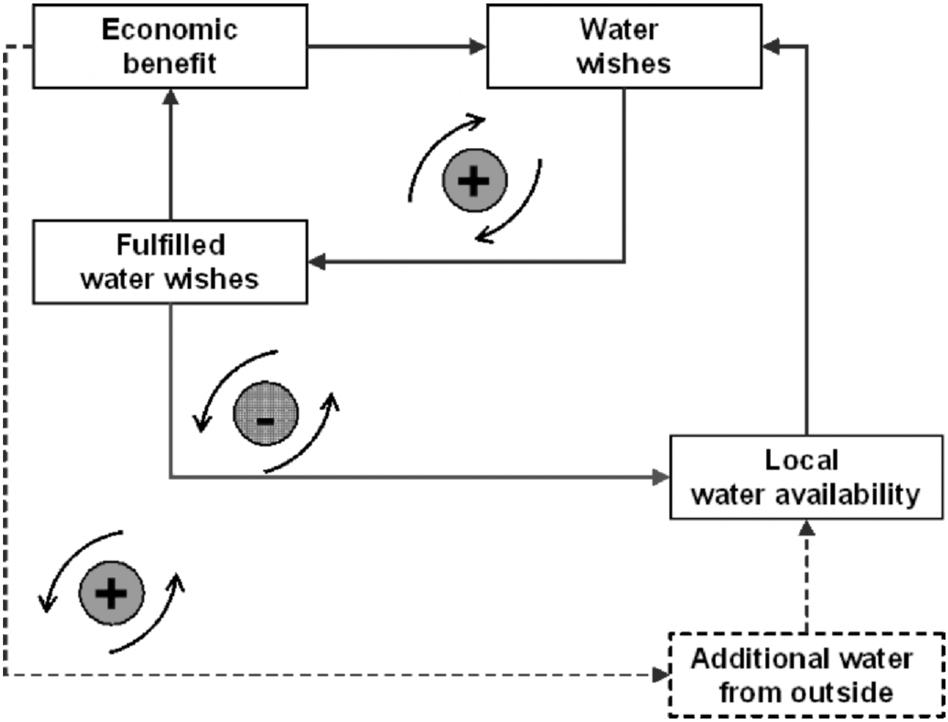

Figure 8. Aggregated causal-loop diagram for water use. In the local system (*solid lines*) the positive feedback cycle between "fulfilled water wishes", resulting in more "economic benefit" and more "water wishes" is counterbalanced through negative "local water availability" feedback. If there is additional water from outside (*dashed lines*), the balanced feedback system becomes insignificant and the positive feedback builds up rapidly. More water supply leads to more water demand.

Given the current extremely unsustainable situation, we have explored two options for a more sustainable future. Our analysis of the supply-driven scenario shows that the Red–Dead project may help to reverse the water inflow deficit and to reverse the current downward trend of water levels. However, this "solution" will not help the core of the problem, namely the extensive exploittation of the flow from the lower River Jordan.

Thus we have also explored an alternative solution for "more water from the outside", yet with an emphasis toward the native state of the system, namely on a partial restoration of the Jordan River flow. The second option shows that the Dead Sea in the south of the region may be restored with a cascading system of local water supply solutions: Israel (which is the only country in the region in which the major urban habitations are along the sea) can economically afford to replace the water from the Lake Tiberias through a series of desalination plants along the Mediterranean Coast. This will release water from Lake Tiberias and restore about 40% of the original flow of the Jordan River. Palestinians would also benefit from the Israeli desalination by easing pressure on the mountain aquifers that Israeli water pumping station put on them. The restoration of the Jordan River will then be able to revive the riverine ecosystem along its meanders. However, it also became clear that with projected population growth – particularly in the Palestinian parts of the region – much of the additional water will be needed for the population. While supporting the restoration of nature in the lower Jordan valley this solution will have a much more limited effect on the restoration of the Dead Sea. Thus we foresee the need of a multifaceted solution that consists of several elements of the different options.

First, we call for an end to evaporation potash mining by the Jordanian and Israeli companies. It is foreseen that during 2015–2020 the mining may probably come to an end anyway because siltation of evaporation ponds will make the operations economically less favorable. In that case governments must ensure that the operations are phased out in a way that does not leave a saline dust in the southern basin of the Dead Sea. The closing of the pumpage to the ponds will also negatively affect the Israeli tourism industry that totally depends on artificially pumped water from the northern basin. Once this pumping stops and once the adjacent ponds have dried up, the outlook for tourism is not favorably. Tourism will probably need to relocate to the northern shores, taking with them jobs and populations.

Second, we call for a restoration of the flow of the lower Jordan River. This will not only benefit the Dead Sea but the overall lower Jordan valley riverine ecosystem. This restoration will also signal a first attempt to acknowledge nature to be a legitimate water user by its own right.

Third, given the projected high population increase and the need for adequate water supply it will be possible inevitable to follow up on the idea of bringing into the area additional water from outside, be it from the Red Sea or from the Dead Sea. In both cases, however, pursuers of the project must be aware that "bringing new water" is not only a physical problem (e.g. with respect to water chemical and physical properties) but a social and governance problem. Additional water means additional power. Issues that need to be addressed are: who will have control of the newly available power? Who will be able to accumulate it? Who will be empowered and disempowered by it? Thus we foresee the need for not only a thorough environmental impact assessment, but for a social impact assessment as well.

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CREATING A SUSTAINABLE FUTURE FOR ISRAELIS AND PALESTINIANS

The role of nongovernmental organizations (NGOs) in promoting cooperation over environmental issues during the period 1992–2006

ROBIN TWITE*
Environment and Water Program, Israel Palestine Center for Research and Information (IPCRI), POB 9321, Jerusalem 91092, Israel

Abstract: For the last 14 years, nongovernmental organizations (NGOs) from Israel and Palestine have worked together in an attempt to create a sustainable environmental future for both peoples; particularly those organizations focused on the management of limited water resources in the region. Their work has involved setting-up joint research projects, organizing conferences and seminars, promoting exchange of information, and fostering public awareness of environmental issues. While many such activities have been carried out with the blessing of the Israeli government and the Palestinian Authority, others have taken place without official approval. This article describes the work being done and attempts an assessment of what has been achieved.

Keywords: cooperation; NGOs; funding

1. Introduction

There are a few points of light in the dark tunnel of conflict that Israelis and Palestinians have entered, most notably by those individuals and organizations who perceive clearly that the future of the two peoples is inextricably intertwined and that there is no alternative to cooperation and creating a shared future which will benefit both parties. This was demonstrated in the field of the environment when in 1992 the Multilateral Environmental Working Group was

*To whom correspondence should be addressed. Robin Twite, Director, Environment and Water Program, Israel Palestine Center for Research and Information(IPCRI), POB 9321, Jerusalem 91092, Israel. E-mail: Robin@ipcri.org.

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created and in the prominence given to environmental considerations when the authors of the Oslo Accords set out detailed guidelines for the future of the peace process between Israel and Palestine. Many paragraphs of the Accords dealt with water issues and others referred in smaller compass to more general environmental issues.

There are a number of individuals and nongovernmental organizations (NGOs) in the region who share the perception that in the small geographical area that provides a home for Israelis and Palestinians there is no alternative but to manage and care for the available limited resources jointly. Water scarcity, continuing growth in population, reduction of open space, air pollution, rapid deterioration of the quality of the air, and ever increasing amounts of solid and hazardous waste are only the most evident of the dangers facing the region. To deal with them requires a common effort by both peoples at the governmental level and in civil society as a whole. In an ideal world, every Israeli and Palestinian would be environmentally aware and help to protect the very ground beneath their feet and the air that they breath. However, as we all know, this is far from an ideal world.

This article deals with the work of NGOs concerned with environmental cooperation in Israel and Palestine, attempts to put such work in the context of the Israeli/Palestinian conflict, and assesses its overall contribution to creating a sustainable environment in the region.

It is evident that all such NGOs must involve the academic community in their work. Many academic institutions have launched their own research programs in cooperation with Palestinian academics and experts. While Palestinian universities (with the exception of Al Quds University) will not enter into formal research agreements with their Israeli counterparts, they have no objection to their staff doing so. Prominent research institutions such as the Truman Institute for Peace at the Hebrew University of Jerusalem, and comparable specialist institutes in all the major universities of Israel have played a significant part in research projects (some of them relating to water and environmental concerns) in which both Israeli and Palestinian academics are involved. Such projects have been deliberately designed to stimulate academic cooperation in the region. This article concentrates on NGOs, but it is evident that much of their work is dependent on collaboration with the individual academics and experts from both Israel and Palestine who give it their support.

2. The Place of the Environment in Israeli/Palestinian Official Dialogue

Before turning to the actual work of some of the more prominent NGOs that provide a framework for cooperation and specialize in promoting it, it is worth looking at the official channels, which have over the years promoted cooperation between ministries and governmental agencies in Israel and Palestine. From the time that the Palestinian Authority was established, both the Ministry of Environment in Israel and its Palestinian counterpart, the Palestinian Environmental Quality Agency (formerly the Ministry of Environment) of the Palestinian Authority were aware of their need to work together. This need was anticipated at the Middle East Conference on regional issues held in January 1992, in Moscow, where it was agreed that a Multilateral Environmental Working Group should be established (one of a number of such bodies dealing with important topics such as the future of refugees and economic cooperation) to bring together Israeli and Palestinian officials and experts with representatives of donor countries and organizations that were interested in promoting the environmental welfare of the region as a whole (Oka, 2002). The meetings of this body continued for a period of years at regular intervals and saw some positive results – among them the creation of a research center in Oman (the operation of which both Israelis and Palestinians are involved) and the provision for the sharing of environmental data.

A little later, as a result of the Oslo Accords, Israelis and Palestinians agreed on the creation of a Joint Water Committee, which would oversee the supply, quality, and distribution of water in the West Bank and Gaza, and on which representatives of the Israeli Water Commission and the Palestinian Water Authority would sit as equal partners.

The Multilateral Committee on the Environment and the Joint Water Committee had somewhat different destinies. The Multilateral Committee became gradually more confrontational as a result of ups and downs in the overall political relationship between Israel and the Palestinian Authority. By 2000, its meetings ceased, although some limited cooperation in the Oman Center and data sharing continues until today. But it is fair to say that the high hopes nourished in the early 1990s that the work of the Multilateral Committee would galvanize effective action to preserve the environment in the region were never realized. The Joint Water Committee, on the other hand, continued its work on a regular basis, even during periods of the most violent confrontations in the period from 2000 to 2003 (Jagerskog, 2005). Both sides recognized that there had to be a mechanism for permitting discussion about water issues and for making administrative decisions about action on the ground, such as the digging of new wells or the provision of additional distribution systems. While meetings of the Committee have often been difficult, and the Palestinians have been left with little doubt that the power resides with the Israeli team, still these meetings have provided a framework for joint action. Only in the last few months when the election of Hamas has prevented all contact between officials from Israel and those from the Palestinian Authority has the future of the Committee become uncertain.

Besides these formal structures for government-to-government cooperation, there was, of course, day-to-day contact between officials. The number, extent, and significance of these varied with the political situation. In 1997, when Rafael Eitan, a right-wing politician, was appointed Minister of Environment of Israel he discouraged his officials from doing more than the minimum necessary to keep channels of communication open. Later, in the period of Ehud Barak's Ministry, the then Israeli Minister shared photo opportunities with her Palestinian counterpart and prospects for cooperation looked better. The outbreak of the violence in 2000 effectively ended cooperation between the Israeli government and the Palestinian Authority. At that time, the Palestinian head of what is now known as the Environmental Quality Agency categorically stated that he and his staff would not work with Israelis either at governmental nor nongovernmental level.

In an attempt to bridge this gap, the United Nations Environmental Program (UNEP) initiated a study of the environment, in the "Occupied Palestinian Territories" that took place in 2002 and resulted in a report and a series of recommendations made to both the Palestinian Authority and the Israeli Government (UNEP, 2003), but the generally adverse political atmosphere that existed when the report was published meant that there was no effective response to them.

It is true to say that over the last 14 years the difficult relations between Israeli governments and the Palestinian Authority were paralleled by those between individual officials and were never as close as was needed if environmental and water problems were to be tackled effectively. It was therefore a very positive development when certain NGOs and academic institutions began to supplement the work of governments.

3. The Work of NGOs in Preserving the Environment of Israel and Palestine through Cooperative Programs

From the 1960s onwards, Israel developed a network of environmental organizations, some of the most prominent being the Society for the Protection of Nature, the Israel Union for Environmental Defense, and Green Action. Between them, these organizations, and tens of others, have worked to create environmental awareness at all levels in society, fought developments which they perceive of as environmentally detrimental, and in general created a situation where the environmental movement is a force to be reckoned with.

In Palestine, NGOs also working on environmental issues acquired prominence, although for different reasons. After the Israeli government obtained control of the West Bank and Gaza in 1967, mechanisms were created which allowed donor funding to reach the Palestinians. These included some prominent and successful NGOs, notably the Palestinian Hydrology Group (PHG), the Palestinian Agricultural Research Committee (PARC), and American Near East Refugee Aid (ANERA) – all of which developed substantial networks for the provision of services to the Palestinian people. With the creation of the Palestinian Authority, these networks continued to exist and ran parallel with the services provided by the Authority, a fact which occasionally created tension. In addition to such NGOs which had an executive role, others were created in the 1990s that concerned themselves with research, such as the Applied Research Institute Jerusalem (ARIJ). However, it seems fair to say that on the whole the environmental movement in Palestine has a somewhat more limited character than that in Israel; there is, for example, no Palestinian NGO with a wide public membership such as that enjoyed by the Society for the Protection of Nature in Israel and little sign of an organized environmental movement.

Though all of the NGOs mentioned above, both Israeli and Palestinian, are evidently aware of the need for regional cooperation to help preserve the environment, they have not made such cooperation their main concern. Many have taken part in collaborative projects with their opposite numbers, but they have, for very good reasons, had to concentrate on their own constituencies.

It was in an attempt to fill this gap that two NGOs came into existence in the 1990s, which were controlled jointly by Israelis and Palestinians. These made it their prime concern to foster collaborative projects between the two peoples. Among them were the environmental program of the Israel Palestine Center for Research and Information (IPCRI) and Friends of the Earth Middle East (known as ECOPEACE in its early years).

In the late 1990s, two Israeli-managed NGOs began to make a significant contribution. The programs of the Arava Institute for Environmental Studies at Kibbutz Ketura in Israel were primarily intended to train young environmentalists from Israel, Palestine, and other Middle Eastern countries alongside students from the USA and have been an undoubted success. The Peres Center in Tel Aviv, a major NGO established to promote cooperation in the region over a very broad range of issues, has also interested itself in water and environmental issues.

The IPCRI program has aimed to create working relationships between environmentalists from Israel and Palestine. From its outset in 1994 it has made it possible for those concerned with the environment from the two communities to meet and work together. In its early days, it concentrated on conferences and seminars at which individuals working in the field could get to know one another, share their common anxieties, and develop long-term working relationships (Twite and Issac, 1994). Over the years, IPCRI has organized joint research projects working with professionals over concerns such as the danger from dioxins, the adverse effects on health of lead emissions, management of water resources in shared water basins, the disposal of hazardous waste, and the potential impacts of global warming. In 2000, IPCRI launched a program for training environmental mediators, which has had some success even in the current confrontational situation. In 2004, IPCRI organized the second international conference on water issues in the region, which was attended by some 200 participants from the Middle East, Europe, and North America; selections from the proceedings are to be published.

The program as a whole is designed to involve professionals and has had an academic flavor. It has enjoyed the support of the governmental agencies and a large number of academics in both societies. For example, in 2004 the Israeli Water Commissioner and his Palestinian counterpart took part in a seminar in Stockholm organized jointly by IPCRI and the Stockholm International Water Institute.

The programs of the active and effective organization Friends of the Earth Middle East has dealt over the years with a number of fundamental concerns. Directed jointly by Israelis, Palestinians, and Jordanians, it has devoted much effort to the question of the future of the Dead Sea. Examples of their Dead Sea initiatives are: plans made by the various governments have been examined and criticized, an effort made to make the Dead Sea a UNESCO World Heritage Site, and attention drawn to the fact that the future of the Dead Sea is in doubt (currently its level declines by about one meter a year) unless more decisive action is taken. Other prominent activities include a grassroots program conducted in Israeli and Palestinian rural communities aimed to create awareness of water issues, work on the protection of the coastlines of Israel and Palestine, and a study of the pollution of the mountain aquifer, vital for both Israel and Palestine (Tagar, 2004). Friends of the Earth is an effective advocacy organization with a high public profile, which works both at a grassroots and professional level.

The Arava Institute for Environmental Studies offers students a 1-year course on environmental subjects and also an MA and MSc. managed jointly with the Ben Gurion University. It makes every effort to include among its students individuals from the whole region. The program has been in existence for 10 years and has been remarkably successful. Its graduates are now to be found holding positions of importance in many environmentally related institutions in Israel and Palestine. Since 2000, the Institute has developed a research program which has included a study of aspects of the hydrology and environment of the Dead Sea (Lipchin et al., 2005) and a comparable study of hydrological issues in the Wadi Gaza/Nahal Bezor basin. The Institute's home in the Arava Valley has become a center for a variety of cooperative activities designed to help foster a sense of shared responsibility for the environment among the people of the region.

All of these organizations are run by small and dedicated staffs who are assisted by volunteers, but none is a membership organization. Finding funds to pay staff at a reasonable level is a major preoccupation for them all.

Altogether the conduct of programs such as those outlined above is no easy matter, political considerations are always apparent and the logistical problems loom large for those organizing seminars and conferences. For example, many of the meetings which IPCRI has organized over the years were held in Turkey since participants were unable to move freely within Israel and Palestine. Those taking part in them have had to recognize that the effort they put in compared with the results, is much greater than the case in a normal situation.

4. Where Does the Money Come From?

Funding for the various NGOs involved in Israeli/Palestinian dialogue over environmental concerns comes largely from the international community. International organizations such as the European Union, the World Bank and UN agencies, and the bilateral aid programs of governments involved in the peace process. The United States, Canada, and a variety of European countries, have all at various times supported environmental programs organized by the NGOs mentioned above. Several large foundations based in Europe and North America have also made major contributions. The total amount invested in such joint research projects, conferences, seminars, and other activities conducted by NGOs is, however, small by international standards. No accurate figures are available, but a rational guess would put the figure at not more than two million dollars a year at the most. This does not, of course, include the cost of major research projects being conducted by academic institutions to which reference has been made earlier.

There is a certain amount of competition among the NGOs for funding and all are compelled to devote much time to fund-raising. None of the NGOs working directly on relations between Israelis and Palestinians is a membership organization and none has any substantial endowment, so they are entirely dependent on their ability to convince donors of their ability to carry out useful work. This ability tends to be greater when the political situation is positive and tends to diminish when it deteriorates. Donors become discouraged when they fear that their money will be wasted since violence and confrontation will not permit work to be done within a reasonable context and timeframe.

5. Who Has Been Influenced by the Work of NGOs in Promoting Research and Cooperative Activity?

All of the NGOs and academic institutions working in the field under consideration do their best to influence decision-makers and publicize their activity. Such influence can be sought either through personal contact with key individuals, through the publication of books and reports in print and electronic form, and by announcing results of research projects at specially arranged seminars or conferences. It is hard to evaluate the results of the work being done. While those directly involved either as staff members of one of the NGOs or as participants in various projects and activities have no doubt of the value of what they do, others standing outside the actual work being done can be more critical. They can point to the fact that from the Palestinian perspective long-held grievances have scarcely been addressed while in the view of many Israelis the Palestinian Authority has not proved efficient in managing environmental and water concerns and there had been little response to Israeli concerns.

A positive conclusion is that NGOs have had impact on professionals and others directly concerned with water and environmental issues. In a sense, a "water community" has been established which embraces many, if not most, of those people most concerned with these issues in the region. These are men and women who are aware of the needs and desires of the "other" and anxious to work together. But on the other hand, the influence of NGOs on policymakers and on the general public, both in Israel and in Palestine, has probably not been as great as they would have hoped. While policymakers and those working on environmental and water issues on a day-to-day basis in Israel and Palestine have undoubtedly found the activities of the various NGOs positive and, by and large, actively support them, it is hard to see where NGOs have impacted specific decisions or managed to get more than a very small number of ordinary members of the public enthused about the environment. The later is doubly difficult when economic and social futures are clouded by anxieties caused by the conflict in the region.

There is no doubt that thousands of individuals have benefited from the work being done, either by taking part in actual activities or by being awakened to the realities of the environmental situation and the need to make efforts to improve things. But more efforts are needed and more funding is necessary to support them. It is ironic that while both Israelis and Palestinians use love of the land as a prime element in their thinking, and indeed this care for the land fuels the conflict, neither party is prepared to take the necessary steps to preserve its long-term sustainability. It seems very often that it is more important to "own" land and water than to look after it. Efforts to convince those involved in the conflict that they run the risk of destroying the land itself have not been successful. Working together in the region to create a situation where long-term sustainability is ensured could provide a way in which the parties in the conflict could share their concerns, strengthen their economic and social fabric, and help make peace a reality, but it has not yet done so.

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ANNEX

LIST OF PARTICIPANTS AND LECTURES

Eric Abitbol - Concordia University - Peacemedia-Paixmédia, Canada

Hande Akcakoca - Southeastern Anatolia Project (GAP) Regional Development Administration, Turkey

Mutaz Al-Alawi - The Royal Society for the Conservation of Nature, Jordan

Nader Al Khateeb - Water and Environmental Organization, Palestinian Authority

Ilan Alleson - University of Toronto - School of Public Health, Canada

Maria do Ceu Almeida - National Laboratory of Civil Eng.- Hydraulics & Env., Portugal

Lior Asaf - AIES: Stream Restoration Project, Israel

Joy Braunstein - University of Pittsburgh - School of Public and International Affairs, USA

Simona Benfenati - University of Bologna, Italy

Emil Bournaski - Bulgarian Academy of Science Institute of Water Problems, Bulgaria

Chris Bowser - Clark University, USA

Hans Guenter Brauch - Free University of Berlin, Germany

David Brooks - Friends of the Earth Canada, Canada

Francesca de Chatel - Freelance Researcher & Writer, Belgium

Jonathan Chenoweth - University of Surrey - Centre for Environmental Strategy, UK

Alex Cicelsky - Kibbutz Lotan, Israel

Mousa Diabat - Jacob Blaustein Institute for Desert Studies, Israel

Bardukh Gabrielyan - Institute of Hydroecology & Ichthyology, Armenia

Christina Hakopian - Yerevan State U & NGO Intn'l Scientific Research Centre, Armenia

William Hewes - Brown University: Middle Easter Environmenal Futures Project, USA

Samir Hijazin - Ministry of Water & Irrigation (Retired), Jordan

Asu Inan - Gazi University - Eng. & Architecture Fac., Turkey

Eduard Interweis - Ecologic, Institute for International & European Policy, Germany

Paul Jeffrey - Cranfield University - School of Water Science, UK

Amer Kanan - Al-Quds University - Department of Applied Eartha and Environmental Sciences, Palestinian Authority

Rebecca Kay - Clark University, USA

Dorit Kerret - Tel Aviv University, Israel

Alla Khosrovyan - NGO Environmental Survival, Armenia

Samiramis Kutlo - Centre for Environmental Diplomacy, Palestinian Authority

Salam Labadi - Royal Marine Conservation Society of Jordan, Jordan

Sabine Lattemann - German Federal Environmental Agency, Germany

Evgeni Levner - Holon Academic Institute of Technology, Israel

Igor Linkov - Cambridge Environmental, USA

Clive Lipchin - Arava Institute for Environmental Studies, Israel

Tugba Maden - Hacettepe Univeristy - Fac. Of Economics & Adm. Sciences, Turkey

Mohamed Matouq - Al Balka Applied University, Jordan

Mariana Marajieva -, Bulgaria

Gerald Mensah-Coker - UNIS/Necot - HCCS, UK

Pnina Motzafi Haller - Blaustein Institute for Desert Research, Israel

Vera Munteanu - National Institute of Ecology, Rep of Moldova

Suad Musallam - Amman International University, Jordan

Sinaia Netanyahu - Tahal Consulting Eng. & Dept. of Industiral Eng. & Management at BGU, Israel

Susana Neto - Technical University of Lisbon - Urban and Regional Planning (CESUR)

Rachel O'Brien - Allegheny College

Onur Oktem - International Relations - Hydropolitics Specialist

Ursula Oswald - National University of Mexico - Regional Multidisciplinary Center

Eric Pallant - Allegheny College

Amir Paster - Faculty of Engineering Tel Aviv University

Dana Rassas - Jacob Blaustein Institute for Desert Studies

Eva Rathgeber - Joint Chair in Women's Studies - University of Ottawa/ Carleton University

Stuart Schoenfeld - York University

Alison Spodek - Tel Aviv University

Gevorgyan Suren - Yereven State - Institute of Economics

Alon Tal - Ben Gurion University of the Negev

Samer Talozi - Jordan University of Science and Technology

Gagik Torosyan - State Engineering University of Armenia

Boaz Wachtel - Independent Scholar

Ebru Yildiz - Gazi University Eng. & Architecture Faculty

Monica Zavagli - Euro Med Youth Program (Royal Marine Conservation Society of Jordan)