WATER SCARCITY, SECURITY AND DEMOCRACY:
A MEDITERRANEAN MOSAIC

EDITED BY
FRANCESCA DE CHÂTEL, GAIL HOLST-WARHAFT AND TAMMO STEENHUIS

Cornell University
David R. Atkinson Center
for a Sustainable Future

Global Water
Partnership
Mediterranean

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FOREWORD

The Mediterranean and its Water: The Mosaic We Live In

It is often said that the Mediterranean is a melting pot. The process of melting different raw materials results in the creation of a homogeneous fluid. This is not the case in our region. The Mediterranean is a fine mosaic of solid pieces of immense durability: a mosaic of peoples with deep roots, various ethnic and historical backgrounds, and memories imprinted in their DNA; a mosaic of civilizations, religions, ideologies, and philosophies. As in all mosaics, some pieces are damaged or lost and others are replaced by new ones but, despite changes, the centuries-old outline patterns still remain surprisingly visible.

To some extent, this can be explained by the impact of the unique Mediterranean landscape and natural environment on societies and individuals. Water is, perhaps, the most vital of all natural resources in the region, shaping landscapes and, to a large extent, determining the level of development.

The Mediterranean is among the most arid regions in the world. Hosting more than 50 percent of the world's 'water poor' population, or around 180 million of the region's 460 million inhabitants, the Mediterranean holds only 3 percent of the world's freshwater resources. To meet water scarcity problems, Mediterranean peoples have throughout history transformed this challenge into a driver for innovation and social organization. Hopefully their capacity for adaptation and their creative imagination will allow them to address the growing challenges, also in the future.

The Mediterranean is endowed with natural beauty, rich biodiversity, and fertility. It hosts a fast-growing and young (on the southern and eastern shores) population, which has over recent decades adopted unsustainable consumption patterns. The region experiences high anthropogenic pressures from rapid urbanization, tourism, industrial and agricultural development among others, while climate variability and change, in addition to desertification, pollution and loss of biodiversity, form growing threats. Furthermore, the Mediterranean region as a whole currently faces a deep socio-political and economic crisis.

Mediterranean societies strive to ensure sustained economic growth, human security and political stability. In order for this to succeed, the integrated management of water, energy, food and environment has to become a priority issue for governments, societies and business.

Around 90 percent of the water resources in the Balkans are transboundary in nature, while in the Middle East and North Africa more than 70 percent of water resources lie in shared basins. This adds to the complexity of the situation. The evolution of political realities shapes the way these vital resources are managed. In the Balkans, where the Cold War and armed conflict sparked tensions over water sharing in the twentieth century, transboundary cooperation has vastly improved in the past 15 years as exemplified in the Sava Basin (shared between Slovenia, Croatia, Bosnia & Herzegovina, Serbia, and Montenegro) and, increasingly, in the Drin Basin (shared between Greece, Albania, the Former Yugoslav Republic of Macedonia, Kosovo, and Montenegro). In North Africa, where the majority of shared water resources are underground, countries are searching for more steady modes of cooperation over the North Western Sahara Aquifer and the Nubian Sandstone Aquifer. In the Eastern Mediterranean, milestone political agreements have resulted in joint efforts to improve water management, though problems in their subsequent implementation now threaten livelihoods and economic activity. Given the importance of the coastal area for developmental activities in the region, a joint approach to coastal and river basin management from ridge to reef is a defined and urgent need.

Yet the scale of today's water security challenge is often underestimated until a crisis hits. The region offers plenty of such examples related to droughts, floods, pollution, waterborne disease, armed conflict and resulting migration... Though the scale and complexity of this multidimensional challenge are huge, solutions are within reach. Good governance is essential in order to facilitate coordinated efforts and initiatives. Effective participatory policy design, implementation, and monitoring can shape a better future for the region. Accessible information, affordable technologies and innovation, socially sensitive investments, tailor-made and pro-poor fiscal instruments and enforced capacities are just some of the tools needed to make real the shift from policy to action.

> Sustainable solutions to current water challenges will be achieved only by understanding the cultural and practical significance of water in our everyday life, including its emotional, intellectual and moral aspects.

This book is a mosaic on its own. It tells stories, shares ideas, poses questions, and offers answers. It travels through the region and explores its interrelated themes, makes deep-dive stops, connecting the shores, the water and the people. Hopefully, it will become a source of reference and inspiration to better understand some of the makes and breaks of water-related sociopolitical balances that extend beyond water technicalities, but have a sound scientific background. Sincere thanks and appreciation to Prof. Gail (Electra) Holst-Warhaft and Prof. Tammo Steenhuis of Cornell University and Dr. Francesca de Châtel for their cooperation, trust, and initiative.

Sustainable solutions to current water challenges will be achieved only by understanding the cultural and practical significance of water in our everyday life, including its emotional, intellectual and moral aspects. Education, formal and informal, plays an important role in creating the new water culture and enabling the move from simple everyday use to strategic developmental decisions that will allow us to wisely use the most valuable gift of life.

Prof. Michael Scoullos
Chairman, Global Water Partnership-Mediterranean

Introduction

Gail Holst-Warhaft
Professor, Cornell University, Ithaca, U.S.A.

Take water with you;
The future holds a lot of drought.
Mihalis Katsaros

FIGURE 1

One of the few surviving olive groves on the island of Aegina, Greece, after farmers there replaced their ancient olive and almond trees with higer-revenue but water-thirsty pistachio trees. This has resulted in rapid groundwater depletion and salinization.
Photo: Francesca de Châtel, 2013.

It is easy to despair about water. The impetus for this volume is a common concern about the water crisis facing countries around the Mediterranean, the Middle East and beyond. We recognize there are serious problems of scarcity and pollution, especially in the south and east of the region. We also know that increasing population and global climate change suggest that the problem will steadily increase unless something is done. The environmental dimension is often ignored in discussions of the current political and social crises in the region. In fact the environmental and political crises are intimately linked, as the chapters in this volume on Syria and the Sahel make plain (Ch. 9 and 10). In technically advanced or oil-rich countries like Israel and Saudi Arabia, which have already reached a threshold of scarcity, solutions like desalination, use of treated wastewater for irrigation, development of drought-resistant crops, more efficient methods of irrigation, and even cloud-seeding are being used, and neither country depends on agriculture for its survival. For the majority of countries in the region, where agriculture is the main consumer of water, radical reform of agricultural policy and conservation of existing resources must be part of the solution. But these may be the most difficult measures to implement because they demand a fundamental change in people's behavior.

Changing public policy and social behavior towards something as basic as water is complicated. Sometimes it seems impossible, and yet human behavior to water has required regulation ever since agriculture began, and the earliest laws we know of concern water. In the dry lands of the Mediterranean, North Africa, and the Middle East, water was always a precious substance, even if it was free. The first civilizations in the region were dependent on rivers and springs, all of which were invested with sacred significance. These natural sources of water, and the wells from which people drew their water were at the center of cultural and social life. The literature of the ancient world is filled with references to water. Gods, nymphs, heroes, and lovers meet at springs and wells. On his return from Troy, the shipwrecked Odysseus meets Nausicaa and a group of young women washing their clothes in a river on the mythical island of Scheria. In the biblical story of Jacob, the prophet meets Rachel at a well (Gen. 29) where she has come to water her father's flocks. Moses meets the daughters of a priest of Midian (possibly in modern Saudi Arabia) and helps them to water their flocks (Exodus 2). In the Muslim world, water has always been regarded as a gift from God for which humans should be grateful. Mentioned again and again in the Koran, water is the source of all things. Water's sacred nature is reflected in the vision of paradise as a garden watered by four rivers, one of water, one of milk, one of wine, and one of honey (Sura 47:15). Water rituals play an important role in all three religions of the Middle East. Withholding water is the ultimate punishment in a dry landscape. The Hebrew God threatens to withhold rain if the Israelites turn to other gods (Deuteronomy). For their disobedience to God, Adam and Eve are expelled from a garden where water flows and all their needs are satisfied.

Water that is scarce may be sacred, but it is also a natural source of conflict, even a weapon of war. In 2500 BC or thereabout, Urlama, King of Lagash, diverted boundary canals to deprive the neighboring Kingdom of Ummah of water. Improper use of water for purposes of war or gain must have been a common practice among the earliest settlers in the Fertile Crescent. Otherwise there would have been no need for the laws promulgated in the code of Hammurabi, king of ancient Sumer, which dates from 1790 BC. Several of the laws concern water and irrigation, addressing questions of negligence and water theft that were presumably sufficiently common to require strict regulation. Hammurabi's grandson Abi-Eshih dammed the Tigris River to stop the retreat of the rebels who attacked the Sumerian capital between 1720 BC and 1684 BC (Hatami and Gleick 1994: 66)

During the second year of the Peloponnesian War in 430 BC when plague broke out in Athens, the Spartans were accused of poisoning the cisterns of the Piraeus, the source of most of Athens' water. After his Indian conquests, Alexander the Great headed back to Babylon via the Persian Gulf and the Tigris, where he tore down defensive weirs that the Persians had constructed along the river. In the sixth century AD, as the Roman Empire began to decline, the Goths besieged Rome and cut almost all of the aqueducts leading into the city. In 537 AD this siege was successful. The only aqueduct that continued to function was the Aqua Virgo, which ran entirely underground. Saladin was able to defeat the Crusaders at the Horns of Hattin in 1187 by denying them access to water. In some reports, Saladin had sanded up all the wells along the way and had destroyed the villages of the Maronite Christians who would have supplied the Christian army with water (Ibid.).

Water laws are a response to the potential for conflict inherent in a scarce and often unpredictable resource. In the *Laws*, Plato alludes to laws established long before his time by those who farmed the land, laws he calls "excellent" and not in need of adjustment. These laws governing the distribution of water sound surprisingly similar to modern ones:

> ... husbandmen have had of old excellent laws about waters, and there is no reason why we should propose to divert their course: who likes may draw water from the fountain-head of the common stream on to his own land, if he do not cut off the spring which clearly belongs to some other owner; and he may take the water in any direction which he pleases, except through a house or temple or sepulchre, but he must be careful to do no harm beyond the channel. And if there be in any place a natural dryness of the earth, which keeps in the rain from heaven, and causes a deficiency in the supply of water, let him dig down on his own land as far as the clay, and if at this depth he finds no water, let him obtain water from his neighbours, as much, as is required for his servants' drinking, and if his neighbours, too, are limited in their supply, let him have a fixed measure, which shall be determined by the wardens of the country (Plato: bk. 8).

Plato also gives a clear description of an irrigated dry landscape, suggesting that dams and ditches built in the valleys:

> They shall make every part of the country inaccessible to enemies, and as accessible as possible to friends; there shall be ways for man and beasts of burden and for cattle, and they shall take care to have them always as smooth as they can; and shall provide against the rains doing harm instead of good to the land, when they come down from the mountains into the hollow dells; and shall keep in the overflow by the help of works and ditches, in order that the valleys, receiving and drinking up the rain from heaven, and providing fountains and streams in the fields and regions which lie underneath, may furnish even to the dry places plenty of good water. The fountains of water, whether of rivers or of springs, shall be ornamented with plantations and buildings for beauty; and let them bring together the streams in subterraneous channels, and make all things plenteous; and if there be a sacred grove or dedicated precinct in the neighbourhood, they shall conduct the water to the actual temples of the Gods, and so beautify them at all seasons of the year (Plato: bk. 6).

THE CRISIS OF WATER IN THE CONTEMPORARY MEDITERRANEAN

On the hidden beach
white as a dove
we thirsted at noon
but the water was brackish.
George Seferis, "Denial"

Until the twentieth century in the Mediterranean, and still in some parts of the world, it required effort to dig a well, draw up its water, and carry it to one's home. Two of the most ecologically destructive innovations of the twentieth century may have been the mechanized pump, and the associated availability of piped water. Mechanized pumps made it easy to draw up the groundwater of many parts of the region in order to irrigate crops. Piping water to people's fields and houses, despite its positive effects on health and sanitation, made it readily available but reduced its perceived value and encouraged a profligate use of domestic and agricultural water. The result has been a decrease in groundwater levels resulting in salt intrusion in coastal areas and decreased streamflow. In addition and more disturbing is the pollution of aquifers by the disposal of industrial chemicals and the leaching of agricultural chemicals that have diminished the quality of groundwater, and of rivers and streams fed by groundwater.

The reduction in water supply has been accompanied by an increase in population, especially in the poorer countries of the region. As a result there has been massive emigration from rural to urban areas, and from the south to the north (see Ch. 10). The large-scale displacement of peoples who have lived for millennia in rural areas, dependent on growing their own food, has led to a humanitarian and environmental crisis that threatens the security of the region and has already escalated into violence. Ethiopia, Sudan, Egypt, and Syria are all struggling with inadequate and contaminated water supplies, environmental degradation, and social upheaval caused in part by the presence of large numbers of unemployed urban dwellers whose only outlet is to protest against the authorities (see Ch. 9). Countries of the northern Mediterranean with a relatively stable or diminishing population like Portugal, Spain, Italy, and Greece, are all affected by the deluge of refugees fleeing poverty in Africa or war in the Middle East. Climate change is exacerbating the problem, as temperatures in already hot summers rise, and rainfall becomes less reliable.

Rivalry between countries over scarce water resources is likely to get worse. Turkey's massive dam-building project in eastern Anatolia has made Syria and Iraq dependent on that country's benevolence. In a serious crisis, agreements between riparian nations over shared watercourses are only as valuable as the paper they are written on. The agreement between Syria and Jordan over the Wahdah Dam on the Yarmouk River continues to be a serious source of tension. In the West Bank, the Israelis and Palestinians have a precarious water-sharing arrangement under an interim agreement made in 1995 which was intended to last five years. It gives Palestinians an inadequate share of the Mountain Aquifer, but since Israel holds a position of superior power, the agreement is not likely to change in the near future (see Ch.14).

FIGURE 2

Ancient olive grove in Aegina, Greece. Photo: Francesca de Châtel, 2013.

WATER POLICY AND SOCIAL CHANGE

As Daniel Hillel wisely points out in his book *Rivers of Eden*, the tendency of political analysts when discussing the Middle East has been to focus on competing demands for a dwindling supply rather than on managing demands within a country (1994: 210). Already, the demand is too high, even though the consumption of water in the countries of the Middle East and North Africa is much lower than in the U.S. with the exception of the United Arab Emirates, where water consumption per head of population may be the highest in the world (Barton n.d.). Conservation, protection, and a rationalization of agricultural policies to adapt to water scarcity are all parts of the solution but they require social change.

In Muslim countries, for example, water has traditionally been free. That may have been a rational policy when the rural population was small and the resources difficult to obtain. Subsistence farmers and individual households may need cheap water to survive, but large-scale irrigated farming uses massive amounts of water (85 percent of water use in the Middle East is in agriculture) (Hillel 1994: 212) and some combination of pricing for excessive use, governmental regulations, and the enforcement of regulations already in place will be necessary in future (see Ch. 12). Resistance to paying for water is strong, and politicians who depend on the rural vote in the democratic countries of southern Europe are reluctant to charge farmers for something they regard as their right. Water pricing is unlikely to be effective unless it is tied to another important tool for managing demand: public education. International organizations, governments and some local authorities in the region are trying to educate the public about the need to conserve water and to recognize the economic value of water for agriculture. However, if farmers are not convinced, even paid, to grow water-saving crops or plant less irrigated acreage, conservation by the public will not be enough to change the situation.

One of the most difficult messages to convey to any population is the necessity to take measures that seem to ask people to go backwards. When water was difficult to access or carry, people used it sparingly. When it became as easy as turning on a tap, there seemed no point in not using as much as you wished. When the farmers of Israel saw a larger profit in avocadoes than olives, they started growing them in irrigated fields using large amounts of water. The result was a serious depletion of their scarce water resources, but Israel is a technically sophisticated and comparatively wealthy country, and farmers now use almost exclusively treated wastewater for agriculture. When farmers on the Greek island of Aegina saw that the price of pistachios was higher than the price of almonds or olives, they uprooted hundred-year old trees to plant the more profitable crop (Fig. 1 and 2). When salt intruded and the water became unsuitable either for agriculture or drinking, it was clear that the price they had paid was too high, but rather than convert wastewater, Greek farmers imported water in the summer months, a solution only available to those who could afford it. The British encouraged Egyptian farmers to grow cotton during the American Civil War when supplies of raw cotton to British mills from the American South were interrupted. Cotton and rice became the staple crops of the Nile Delta, but both use a great amount of water. Until people, especially farmers who have lived for many years in the same area, are forced by necessity or government intervention to change their behavior, they tend to continue doing what they do. Telling farmers to use less water or return to crops that are somewhat less profitable in order to preserve water is a hard sell. But is it fair to the broader population, to the country, the region, even the world, for people to continue what they are doing if it adds to the environmental degradation of the planet?

This raises the very thorny question of whether efficient water management is compatible with democracy. It is a long time since Wittfogel (1957) argued that hydrological societies were by nature despotic, since they required slave labor.[1] From ancient to modern times, the management of irrigation has been an informal arrangement between individual farmers, who have joined into larger groups as the need arose.[2] This has not been the case for large-scale water management, where the construction of large dams, water transfers and major irrigation schemes have been managed by governments, often with no input from local people. Constructing large dams requires large investment and involves displacing people who are seldom satisfied by the arrangements made for their resettlement. These grand water projects, as Reisner (1987) first pointed out in discussing the transformation of the American West and Mairal has demonstrated for Spain and the U.S. (2010: 27-49) were often linked to a founding myth of the nation, and to a messianic vision of redemption. Only the large-scale manipulation of water resources could transform the desert into Promised Land. To persuade a state to undertake such massive projects required either a dictatorial regime or a visionary architect. In Spain, the most influential figure in the formation of a national water policy was Joachim Costa. Costa was not a religious man but a lawyer who drew on biblical texts to support his vision. The epitaph on his mausoleum in Zaragoza reflects the messianic nature of his policy. Costa is described as a "new Moses". "With the rod of his impassioned words he brought forth the spring of water in the sterile desert. He conceived new laws to bring his people to a land of promise" (Ibid.: 38).

If Costa, or his counterpart, geologist John Powell in the U.S., were to see the grand schemes they envisaged realized, they knew that biblical rhetoric was the best weapon they had. They were both able to influence national water policy in the early twentieth century, in an era when the ecological and local effects of large-scale transformations of the landscape were not considered in any negative light. What mattered was to expand, to conquer, to tame the land in the service of the nation. Paradise, in the Hebrew Bible, is a garden, rather than a wilderness.[3] Wilderness and desert are one. Transforming the desert into an earthly paradise provided a mythical basis for water policy, and more broadly for a national consciousness.

The mega-dam, as Max Haiven writes, "became a critical icon of post-colonial nation-building, the royal road to an autonomous modernity that promised electrical power for civil infrastructure and industrial use, better irrigation and access to intensive irrigation practices, and more stable water transportation and water supplies" (2013: 217). This was true of Nasser's nationalist project to build the Aswan Dam in Egypt, which improved food production downstream, but had a catastrophic effect on the Nubian people, and contributed to the Suez crisis of 1956 (Fig. 3); it was also true of India, where Jawarharlal Nehru conceived of large dam projects he encouraged as a way to unify the country, describing them as "the temples of modern India" (Ibid.: 219). The series of dams constructed in eastern Anatolia in areas where the Kurdish people had lived for centuries served as a nationalist symbol for the Turkish government. It is a tool for controlling the rebellious Kurds, but also a powerful weapon in any future conflict with the downstream countries, Iraq and Syria.

The reality of dwindling water supplies and the obvious environmental and social damage caused by large-scale water projects has affected water policy in dramatic ways. In Spain and

FIGURE 3

Construction of the Aswan High Dam, Egypt. Source: Life Magazine, 1964. Zeinab Mohamed.

the U.S., for example, where similarly grandiose schemes were popular with the majority of the population less than a century ago, there has been an awakening, among a coalition of scientists, environmental activists, and local residents, that the era of such plans has ended, and solutions to problems of water scarcity must focus on conservation rather than the construction of dams and water transfers.

The chapters that follow offer a variety of perspectives on the problems of water in the Mediterranean and the Middle East. The authors come from a variety of countries and disciplines, and their approaches to the issue are quite diverse. This was a deliberate choice; we recognize that solutions to the crisis of fresh water in the region can only be arrived at by what we refer to as a "mosaic" approach. The crisis of water in the region differs from north to south, from west to east and from country to country. Some issues, like climate change, affect the region as a whole; others are specific to a particular country or a group of countries. There is a world of difference, for example, between the resources available to the countries of the northern Mediterranean, and the poverty, social unrest, and rapidly increasing population of the south. But water is a problem for all of these countries, and solutions found in one country may, in time, be applied in another. More importantly, addressing the problem of water shortage and pollution in the region requires a combination of technical, social, economic, political, and cultural knowledge. Only such a mosaic of skills and approaches can hope to alleviate one of the most urgent crises this region has ever faced.

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ENDNOTES

1. Horden and Purcell (2000: 250-51) argue that the management of water for irrigation is generally cooperative rather than imposed from above, and provide examples of various informal arrangements. There is no definitive pattern of organization, but enough variety to refute Wittfogel's theory.
2. My colleague Tammo Steenhuis points out that this would not have worked in Mesopotamia, where quite a high degree of organization would have been necessary to keep the water flowing downstream without causing salinization (personal communication).
3. The word "paradise" is derived from the ancient Persian *pairi-daeeza*, an orchard or walled garden.

I. THE NEW CULTURE OF WATER

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Water sustains all.

THALES OF MILETUS, 600 BC

In time and with water, everything changes.

LEONARDO DA VINCI, 1452-1519

We forget that the water cycle and the life cycle are one.

JACQUES COUSTEAU, FRENCH EXPLORER 1910-1977

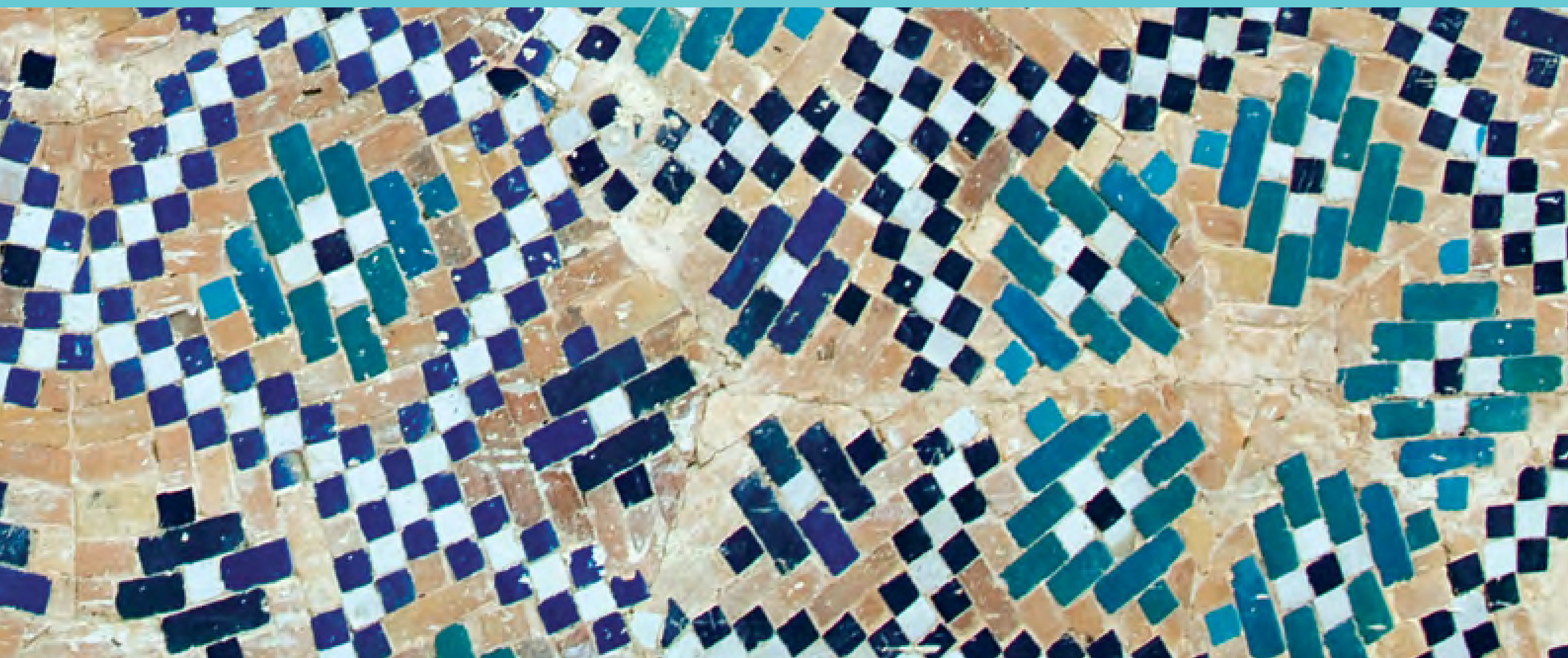


FIGURE 1

Abstract

How can we restore the heritage of Venice's historic inland waterways? How can we protect the Venice Lagoon from the impact of mass tourism and pollution by millions of plastic bottles that are discarded every year? And how can we develop a museum concept that tells the rich history of water civilizations, but also changes common perceptions of and attitudes to water? More than ever, new methodical approaches that combine past and present water management models in an interdisciplinary context are necessary to ensure sustainable growth, cooperation, conflict resolution, and democracy in the Mediterranean region. The Italian NGO *Civiltà dell'Acqua* is helping to address these issues through specific projects.

KEYWORDS: WATER RESOURCES MANAGEMENT, WATERWAYS, TRADITIONAL KNOWLEDGE, WATER MUSEUM, WATER CIVILIZATION, NEW WATER CULTURE

1. Glimpses of a New Water Civilization

Eriberto Eulisse
Director of the International Center
Civiltà dell'Acqua, Venice, Italy

"Each existence owes the intonation of its voice to the presence or the mirage of waters that have crossed it"
Renzo Franzin (2005)

The famous Villa Contarini of Piazzola sul Brenta (Padua): an outstanding example of sixteenth-century waterscape architecture by Andrea Palladio. Source: *Civiltà dell'Acqua* Photographic Archive.

CIVILTÀ DELL'ACQUA

The International Center *Civiltà dell'Acqua* (Water Civilization) is a non-governmental, non-profit organization located in Venice, Italy. As encoded in its Charter in 1998, the center's ethical aim is to change present-day perceptions of water by introducing the concept of a New Water Culture to counter the current reductive cultural vision of water, and to support interdisciplinary research activities that seek alternative solutions to non-sustainable water uses.

For more information see www.civiltacqua.org.

Properly combined, a knowledge of past water civilizations and a knowledge related to powerful modern water technologies are both essential ingredients for projects that aim to build a more sustainable future. On the one hand, the consideration of so-called "traditional knowledge"[1] seems more necessary than ever, particularly the principles that inspired the far-sighted water management models that allowed major hydraulic civilizations and small-scale societies to survive and prosper in water-scarce environments. However, this is not enough to properly address the magnitude of the present global water crisis (see Introduction and Ch. 8).

On the other hand, it is clear that modern technology alone can no longer solve the water crisis we face, though it has indeed contributed to resolving some of today's water challenges. In the Mediterranean and the Middle East, the depletion of aquifers, salinization, desertification, water scarcity and flooding are growing problems that neither modern technology nor traditional knowledge alone can solve. In this sense, new connections between past and present water management models and know-how are more necessary than ever (Beck 1988, Ostrom 1990, Laureano 2003, Diamond 2004, Holst-Warhaft and Steenhuis 2010). Future water challenges in the Mediterranean and Middle East call for innovative, creative, interdisciplinary combinations between past and present knowledge, particularly with regards to the development of more sustainable water management models (see Introduction).

The chief goal of *Civiltà dell'Acqua* is to build a New Water Civilization: an objective that perfectly matches the aims of the New Water Culture Declaration of Madrid (2005) (see Ch. 4).[2] But beyond speculative declarations, what kind of concrete projects can achieve such an ambitious goal concerning water and democracy in the Mediterranean and Middle East?

This article will show that new water management models can benefit from past paradigmatic experiences to develop more far-sighted and sustainable approaches to the application of new water technologies. I will present a few projects launched by *Civiltà dell'Acqua* to change common perceptions of and behavior towards water in the region of Venice, Italy. Starting from the forgotten heritage of the Venetian inland waterway system, I will highlight some important issues that could also contribute to building a New Water Culture in other less-developed areas of the Mediterranean, within a framework that simultaneously stimulates local competitiveness, sustainable growth, democracy, public involvement and conflict resolution.

The historic canals of Venice are world famous. Yet few people know about the artificial canal system that the Venetians built in their hinterland over the space of several centuries. Today this precious heritage is heavily undervalued and has fallen into a worrying state of disrepair. What can be done to salvage this valuable example of water civilization from permanent and irreversible loss?

Another great challenge facing the modern city of Venice is the disposal of approximately 40 million plastic bottles that are annually discarded by millions of tourists. This, in addition to the other waste tourists bring, is a heavy burden on a city of less than 60,000 inhabitants in the

New connections between past and present water management models and know-how are more necessary than ever.

fragile environment of the Venice Lagoon. It also raises questions about the need for bottled water in a place where high-quality fresh water is abundantly available, not to mention the expense of collecting and processing the empty bottles. Who should cover this cost? Passing tourists or Venetians? To address these issues and to change the widespread negative attitudes towards the quality of water in the city's public fountains, *Civiltà dell'Acqua* recently launched the campaign DRINK...VENICE!

Finally, the article will present plans for the ambitious Water Museum of Venice, which will explore the richness of different historic "water worlds"[3] and show how they can contribute to more sustainable water use in the present. The permanent exhibition spans from ancient Roman aqueducts to Arab underground canals (*qanats* or *khettaras*); from Venetian rainwater-harvesting systems to a series of remarkable hydraulic civilizations around the world. Starting in the Mediterranean and the Middle East, the museum will also explore examples of other important hydraulic civilizations in Africa, the Americas, Central Asia, China, India, and Oceania.

The main sections of the museum will use innovative hands-on technology to explore key issues related to water crises around the world, from the impact of climate change to the right to water; from traditional community drought- and flood- management practices to the need for river restoration in order to rehabilitate the natural cycle of aquatic ecosystems. As such, the Water Museum of Venice is an ambitious extension of the educational activities that *Civiltà dell'Acqua* has carried out since 1998, such as the international web project DROPS OF WATER, which it implemented for UNESCO's Venice Office.[4]

A SHORT HISTORY OF THE FORGOTTEN CANALS OF VENICE

For more than six hundred years, between the twelfth and eighteenth centuries, the Venetians carried out extensive hydraulic work to control and divert watercourses, continuously modifying major rivers, including the Po, which naturally flow into the Venice Lagoon and its vicinity.

Historically, such manmade endeavors to control and divert watercourses have profoundly transformed the local environment. Similar transformations require highly specialized technical knowledge to deal with specific natural landforms and hydromorphologies, while at the same time reflecting specific cultural and socioeconomic contexts. Yet despite the high sophistication of this historic water landscape, the rich heritage of the Venice waterway system with its inland canals is today largely forgotten.[5] Indeed, the city of Venice is renowned for its historic role as a maritime power that dominated

FIGURE 2

Eighteenth-century map of the Venice Dogado by Paolo Bartolommeo Clarici and Giacomo Cantelli. In the upper left corner near Longare (Vicenza), one can see how the Bacchiglione River was diverted to create a new navigable waterway. The resulting artificial canal, the Bisatto (completed in 1139), flows beneath the Euganean Hills to connect the city of Vicenza to the Venice Lagoon through Este, Monselice (Moncelese) and Battaglia. Source: Image courtesy of the Municipal Library of Battaglia Terme (Padua).

trade and exchange across the Mediterranean Sea, but its local efforts to control rivers in order to boost regional trade and prevent the Venice Lagoon from silting up are generally overlooked. But before exploring how this precious heritage can be reinstated, it is worth briefly examining the history of the Venice waterway system, its construction, and its pivotal importance to the city until the fall of the *Serenissima* Republic in 1797.[6]

The present-day hydrography of the Venetian hinterland is the result of a long history of human interventions that date back at least to the Middle Ages.

Historic cartography (Fig. 2) shows that Venice's hinterland features a considerable number of alpine rivers and resurgent watercourses. These naturally join the region's main rivers such as the Po, Adige, Bacchiglione, Brenta and Piave Rivers, which discharge into the Adriatic Sea. Due to differences in water levels and irregular flow patterns, these rivers and streams are not all suitable for inland navigation. Instead, a series of artificial canals built from the twelfth century onwards strengthened the connections between Venice and Ferrara, Mantua, Milan, Padua, Pavia, Verona, as well as a number of minor towns, creating an extensive network of navigable waterways that allowed for easy transportation of both goods and troops. Thus the present-day hydrography of the Venetian hinterland is the result of a long history of human interventions that date back at least to the Middle Ages (Vallerani 2012).

Milan and Venice acquired and developed their skills to control watercourses and create artificial waterway systems locally as early as the Middle Ages, while Atlantic Europe only applied its knowledge and skills at a later stage (Ciriacono 2006). In the Venice region, the local hydrography was first modified in the first half of the twelfth century, when two rival towns near Venice, Padua and Vicenza, underwent a period of significant expansion. The two feuding towns considered control over the local hydrography a strategic asset, as it allowed them to defend their urban communities and provision them via the more efficient system of waterway-based trade (Vallerani 2012).

According to chronicles from the time, the inhabitants of Vicenza diverted the water of the Bacchiglione River to connect their city to Venice and its expanding trade in the Mediterranean. Built in 1139, the fifty-kilometer Bisatto Canal circumnavigated the Euganean Hills via Este and Monselice (Fig. 2) to shorten the journey to the Venetian Lagoon and avoid any transit fees from their downstream

FIGURE 3

Renaissance fountain in the Catajo Castle (Battaglia Terme, Padua). The Venetian fortress built by the Obizzi family to control this waterway segment was embellished with fanciful fountains and water games. Source: *Civiltà dell'Acqua* Photographic Archive.

rival, the city of Padua. A few decades later, Padua also diverted the Bacchiglione and completed a second circular navigable route around the Euganean Hills for its own interests by building one of the most complex surviving hydraulic feats in northern Italy: the Canale Battaglia (1189-1201).[7] This straight, twenty-kilometer-long canal (Fig. 4) ensured an alternative river route to Venice. In 1209 the construction of the Piovego Canal provided even faster and more secure access to the *Serenissima* Republic, connecting the river port of Padua to the *Naviglio* of Brenta, an artificial waterway built along an earlier course of the Brenta River.

The Brenta *Naviglio* waterway was improved in the fourteenth century with the construction of the Canale Brentella (1314), which ensured that this Venetian waterway received a constant supply of fresh water even during drought periods. This further stimulated river trade between Venice and Padua.

FIGURE 4

The historic Battaglia Canal in the 1950s. This canal was completed in 1201 in order to connect Padua to the waterway system in the Euganean Hills. Source: Image courtesy of the River Navigation Museum, Battaglia Terme (Padua).

Beyond trade opportunities, the Venetian waterways also became a popular leisure spot among the Venetian aristocracy who commissioned the design and construction of grand villas and gardens and thus created a unique waterscape in the Venetian hinterland that is today known as the *Riviera* (or *Naviglio*) del Brenta. Also known as the "elongated Grand Canal", this thirty-kilometer artificial waterway that links Venice to Padua is lined with iconic estates such as Villa Pisani, Villa Malcontenta, Catajo Castle, and the Villa of Piazzola sul Brenta designed by architects such as Andrea Palladio (Figs. 1 and 3).

After the fall of Constantinople in 1476, the interests of the Venetian aristocracy increasingly shifted towards the mainland and its waterway system, where considerable capital was invested to develop a modern form of agriculture along the waterways, and control and divert rivers in order to protect the Venice Lagoon from silting. From the Renaissance period onwards, Venetian hydraulic engineers increasingly focused their efforts on preventing all fresh water from flowing into the lagoon, in order to avoid silt deposits which would eventually have connected the city to the mainland, which would in turn have destroyed its natural defense barrier. A number of well-known *Savi delle Acque* (Water Masters), including Cristoforo Sabbadino (1489-1560), embarked on a series of public works between 1601 and 1684 to systematically divert all watercourses flowing into the lagoon: from the Brenta to the Po, from the Sile to the Piave Rivers (Vallerani 2012).

After the fall of the *Serenissima* Republic in 1797, the Venetian waterway system remained in use and was maintained until World War II. But in the 1950s and 1960s, as road transportation became more efficient, trade along the waterways declined dramatically (Fig. 5) and was followed soon afterwards by growing neglect and indifference towards this historic hydraulic heritage (Vallerani 1994).

FIGURE 5

The *bùrci* (traditional wooden boats) cemetery on the Sile River near Treviso (Italy). Centuries of inland navigation in the Venice region stopped abruptly in the 1960s, when the road transport system was developed and Italian public policy decreed the end of local nautical practices. Source: *Civiltà dell'Acqua* Photographic Archive.

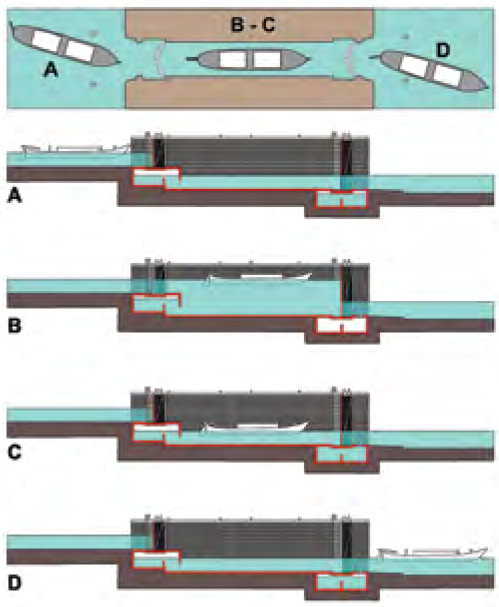
A WATERSCAPE HERITAGE

According to Schama (1995), waterway systems are a unique encapsulation of memories and scenarios resulting from the constant interaction between human activity and natural conditions, to the point that they offer one of the most recurrent iconic themes in both landscape painting and literature.

Waterway systems are a unique encapsulation of memories and scenarios resulting from the constant interaction between human activity and natural conditions.

The historic waterways of Venice form a complex system of hydraulic infrastructures, in which the interaction between traditional hydraulic knowledge and valuable environmental contexts has created a number of cultural landscapes with genuine aesthetic value. Many of these historic waterways still feature unique waterscapes and artifacts, such as stone bridges, hydraulic factories (water mills and water hammers) (Fig. 7), warehouses, and river ports as well as an ingenious lock system invented by Leonardo da Vinci to overcome differences in water level (Fig. 6). However, unfortunately – with the exception of the *Riviera del Brenta* – the Venetian waterway system has today been almost totally abandoned and allowed to fall into a state of advanced disrepair.

FIGURE 6



Operation scheme (descent transit) of a lock. Locks are crucial to controlling the canal network system. A: opening of upstream doors. B: boat transit in the lock. C: closing of upstream doors and opening of the water valves to lower the water level in the lock. D: opening of downstream doors and exit of the boat. Source: L. Buson.

Recent floods in the Venetian hinterland – triggered largely by a lack of maintenance of the waterways – have refocused some attention on the waterway system, though regular maintenance is still considered too expensive. Yet, the Venetian waterways and their waterscape heritage could form an attractive ecotourism destination for tourists and locals, with activities such as walking, biking and canoeing. Importantly, as stressed by Vallerani (1994 and 2012), unlike intrusive projects such as yachting marinas, responsible river and waterway ecotourism requires only minimal changes to infrastructure. Often all that is required is the restoration and maintenance of already-existing features such as riverside paths, access to the banks (when prevented by private ownership), old docks and historic houses. This can profitably be combined with the marketing of local fresh produce and the organization of leisure activities on the water, such as the use of traditional wooden boats.

Promoting responsible ecotourism, strengthening local competitiveness, preserving and maintaining hydraulic heritage, and countering the destructive dynamics of urban sprawl are key imperatives for the sustainable future of this area that was once crossed by vital waterways (Vallerani 1994 and 2012). Old infrastructure and abandoned hydraulic artifacts along the waterways form a unique combination that may greatly inspire the collective imagination. Such paths along the Venetian waterways allow visitors to immerse themselves in an ancient way of life and discover this rural area in a new light.

FIGURE 7

Nineteenth-century wooden water-wheel. As far back as the Renaissance, and in some cases even the medieval period, a considerable number of hydraulic factories sprang up along the Venetian waterways, taking advantage of the difference in water levels to power the production of flour, textiles, and paper. Source: *Civiltà dell'Acqua* Photographic Archive.

THE EUROPEAN CHARTER OF HISTORIC CANALS AND WATERWAYS

The international workshop organized by *Civiltà dell'Acqua*, UNESCO's Venice Office, and the University of Ca' Foscari in Venice in 2012 highlights the importance of addressing sustainable ecotourism policies at the European level, prioritizing recreational uses of river banks, forests and meadows around historic waterways, and re-evaluating navigable routes and hiking paths.[8] Upgrading historic waterways to the status of cultural heritage sites offers a unique opportunity to revitalize the tourist industry and enhance local income in less-favored regions.

The 2012 workshop concluded with the issuing of the European Charter of Historic Canals and Waterways,[9] which features practical guidelines for policy makers. In order to reverse the marginalization of many of Europe's waterways, the charter's main objectives are:

1. To make a careful inventory of all historic waterways in Europe and support the listing of a representative number as "cultural landscapes" on the UNESCO World Heritage List;

2. To create an international network of institutions and organizations to reinforce local identity, particularly the shared heritage of regions with navigable waterways;

3. To promote new forms of responsible ecotourism along historic waterways, in order to positively impact the complex dynamics of regional competitiveness;

4. To support the rehabilitation and recovery of neglected infrastructure around historic waterways, such as locks, small harbors, bridges, and traditional boats.

The charter's principles and rationale propose fresh and exciting directions for strategic new planning, with an emphasis on adequate promotion and protection, not only of specific riparian contexts, but also of the complex stratification of these waterscapes.

DRINK... VENICE!

FIGURE 8

The registered trademark of DRINK...VENICE!: a project aimed at promoting the use of reusable bottles and encouraging tourists to visit Venice's public fountains in order to reduce the impact of plastic water bottles on the fragile urban environment.

DRINK... VENICE! is a public campaign that is currently being implemented by *Civiltà dell'Acqua* in cooperation with the Venice Municipality. The project was launched in 2013 with the aim of preserving the delicate environment of the Venice Lagoon from pollution by plastic refuse, and creating a more sustainable image of the city.

DRINK... VENICE! aims to turn the city's annual 20 million tourists into potential financial project partners. Indeed, one of the major impacts of mass tourism in Venice is the release of some 40 million plastic water bottles per year in the city.[10] The collection and recycling of this plastic refuse is a major social and environmental problem. At the same time, the majority of tourists are not aware that fountain water forms a viable alternative to bottled water, as all the city's public fountains provide good-quality drinking water that is subject to strict daily monitoring by Veritas, the Venice Water Agency.[11] In fact, the water that flows from Venetian fountains is often of better quality than the water sold in plastic bottles,[12] and it is free.

Most tourists are not aware that fountain water forms a viable alternative to bottled water, as all the city's public fountains provide good-quality drinking water.

DRINK... VENICE! will produce and market reusable glass, plastic and aluminum bottles featuring the project logo (Fig. 8). They will be sold in recycled cardboard packaging along with a map of all the historic fountains still in use, from where free, good-quality, regularly monitored water can be obtained.

The main challenge of DRINK... VENICE! is to reverse common perceptions of and attitudes towards public fountains. Many authors have shown that this challenge is definitely cultural. Bachelard (1942) explored the question from a psychoanalytic perspective and showed that the concept of purity plays a vital role in shaping the myth of bottled water in the collective social unconscious. In *Mythologies*, Roland Barthes (1957) outlined how bottled water advertisements are a perfect example of the forms myth assumes in the contemporary world. As Umberto Eco (1993) has pointed out, common contemporary perceptions of and attitudes towards bottled water tend to consider packaged water as "sacred" and health giving. From this perspective, if technology has destroyed and usurped the sacred aura water once had, the general public inevitably tends to create new images of purity and well-being associated with water, even if they only amount to consumer goods available in shops and on supermarket shelves. It is no coincidence that bottled water labels always show images of unspoiled and remote natural environments, even when the water itself is extracted from deep aquifers. Thus it is easy to understand why traditional public fountains and tap water are generally viewed with increasing suspicion, while the sealed bottle, with its powerful imagery projected in seductive advertisements, is more than able to satisfy the imagination of consumer society (Eulisse 2010).

Similarly, traditional Venetian public water supply systems such as wells, cisterns and public squares (Fig. 9) are today also heavily undervalued. For example, the ingenious system of rainwater harvesting – once known as the "Venetian cistern" in the central and eastern Mediterranean – is today largely overlooked despite the crucial historic role it once played in Venice's water supply. A survey carried out in 1857-58 by Giuseppe Bianco classified more than six thousand cisterns and wells on the island of Venice alone, and showed that cisterns produced a total of 450,000 cubic meters of fresh water per year. This water system therefore had a profound influence on the architecture of Venice, where squares and historic buildings were conceived and built primarily around the need to collect rainwater (Gianighian 2013). Similar rainwater-harvesting systems have been in use in the Venice Lagoon since the Roman period, as highlighted by recent archaeological investigations (D'Agostino and Medas 2010).

Thus Venice has a complex water heritage that is doubly linked to water – both salt and fresh. Nonetheless, in contemporary tourist imagination, the rich hydraulic heritage of fresh water related to ornamental wells and rainwater harvesting has been replaced by the urban and economic mechanisms of bottled water. One consequence of such a misguided perception is that lovely wells and squares that were crucial for the survival of the city through the centuries are today largely abandoned. What is more, they are overwhelmed by the new aesthetic of water as a mere commodity. Perhaps this new aesthetic could be seen in Lévi-Strauss's terms (1962), as an example of a "mythical discourse" of our present civilization in contrast to that of "primitive" people or our own ancestors.

Today new myths related to Venetian waters are no longer forged by the ancestral wisdom of water masters like Cristoforo Sabbadino, who spent his entire life taming rivers and marshes that once seriously threatened the city, or by the myriad anonymous water masters who made functional cisterns and wells to collect rainwater and, in so doing, brought prosperity and fortune to Venice. In Venice, as elsewhere in the world, predominant myths related to water are nowadays shaped by the powerful lobby of bottling companies that not only decide which water should be consumed, but indirectly also spur the loss of local cultures, places and knowledge associated with water.

Civiltà dell'Acqua's DRINK...VENICE! campaign therefore promotes the use of fountains and reusable bottles and supports the development of more sustainable, low-impact tourism. The revenues from sales of the DRINK... VENICE! bottles will support the restoration and maintenance of the most degraded fountains and *campielli*.[13] Project communication will focus on the love of the city, its beauty, its water history, and the quality of its fountain water. This challenge begins in Venice, but could be taken up in the entire Mediterranean Basin, and perhaps beyond.

FIGURE 9

Venetian well decorated with an arch in the Trinity Cloister of the Franciscan Monastery of Santa Maria Gloriosa dei Frari. This well has been in use for centuries, especially for the benefit of poor people. Source: *Civiltà dell'Acqua* Photographic Archive.

THE WATER MUSEUM OF VENICE

The Water Museum of Venice will constantly bridge the gap between scientific research and the general public.

Designed as an exhibition space for the exploration of the cultural-historic relationship between man and water, the Water Museum of Venice will use an innovative approach to disseminate information about different "water worlds"[14] to a broad audience. Indeed, every culture has accumulated a wealth of water knowledge and techniques, which have been passed down through generations. Today, this knowledge base is in danger of disappearing under the homogenizing effects of globalization and the increasingly dominant perceptions of a simplistic, narrow vision of what "water" really is and means. Knowing and understanding the water worlds of the past is a fundamental step towards building a more sustainable "water future" for humanity. In this context, the displays at the Water Museum of Venice will focus on how to combine past and present knowledge with an interdisciplinary approach in order to solve some of today's global water challenges. Indeed, such an investigative approach is the only way to address present water challenges in a sustainable and responsible manner.

The management of scarce water resources should be undertaken with a view to ensuring continued access to quality water for future generations, and with respect for what has been passed down from generation to generation. In this sense, the displays at the Water Museum of Venice are conceived to stimulate a dialogue between past and present water knowledge, preparing the ground for a New Water Civilization. But why should such a task be undertaken by a water museum? After all, international organizations, universities and research centers are increasingly focusing on water issues. However, their effectiveness in communicating the results of scientific and policy research to the general public (and even to decision makers) is often quite limited. An innovative and interactive exhibition space located in a city with a rich water history such as Venice can help to bridge this gap and may have greater impact on international public opinion (Fig. 10).

The exhibit starts with a case study of how water was historically perceived and managed in the so-called Republic of the Lion (Zorzi 2001). Indeed, Venice gave birth to one of the most vibrant water civilizations in the Mediterranean region. However, few tourists know that this city is located in a lagoon with almost no fresh water, and that without the rainwater-harvesting system described above, life here would simply have been impossible. It is precisely in this context that the water history of a city like Venice, which has for centuries relied on wise management of both seawater and fresh water, may provide invaluable lessons to inspire more forward-looking development models for the entire Mediterranean basin. Venice's water history tells us about the knowledge that was developed not only to prevent the sea from invading the city, but also to capture rainwater and manage it carefully for all basic human needs. During the Renaissance period, the Venetian rainwater-harvesting system provided a constant and reliable water supply to one of Europe's most populated cities.

A specific section of the museum will be dedicated to exploring the links between water and religion from an anthropological perspective. Throughout history, all cultures have associated water with sacred and life-giving qualities. Therapeutic springs that burst from the bowels of the earth (Fig. 11), waters of fertility (Fig. 12), purifying waters, sacred and oracular fountains, and deified rivers... all of these concepts seem to have their roots in the deep psychology of mankind (Bachelard 1942, Eliade 1969, Sébillot 1983, Tölle-Kastenbein 1990). The strong spiritual resonance of water has to be understood within local belief systems, where customs, social practices and ancient rites and myths reflect the centrality of water. The ultimate purpose of such symbolic and religious systems has always been to preserve this invaluable resource for the survival of society and future generations.

FIGURE 10

The inner court of Palazzo Canonica in Riva Sette Martiri. The palace is managed by the Institute of Marine Sciences of the National Research Council (CNR-ISMAR) and is one of the possible locations of the Water Museum of Venice. Source: *Civiltà dell'Acqua* Photographic Archive.

FIGURE 11

The underground temple-well of Paulilatino (1500 BC, Sardinia, Italy). Ritual and sacred connotations have been ascribed to the well since prehistoric times. Recent investigations have demonstrated that the spring has a specific astronomical orientation, so the stairway entrance allows direct sunlight to reach the subterranean source during the spring and autumn equinox. Source: Image courtesy of Archeotour, Paulilatino.

FIGURE 12

Before the arrival of the Romans, the sacred springs of Lagole near Calalzo in the Italian Alps were associated with the local goddess Tribusjatis and to rituals of fertility, as demonstrated by recent archaeological discoveries. Water rituals continued to be performed here until the end of the nineteenth century, when an injunction from the Mayor of Calalzo definitively prohibited naked girls from bathing in the springs during St. Johan's night. Source: *Civiltà dell'Acqua* Photographic Archive.

In the remaining museum sections, visitors will learn about different historic uses and perceptions of water in other Mediterranean and global water civilizations, including its supply, use and distribution for human consumption, hydraulic machineries and other "traditional" water technologies. Other displays will elaborate on the great water challenges we face today: water scarcity, droughts and desertification, but also floods and the urgency of river restoration and revitalization.

The ecological and cultural value of water ecosystems and waterscapes will also be emphasized. Indeed, while billions of dollars have been invested globally in recent decades to strengthen artificial networks (dams, reservoirs, irrigation canals, water pipelines and sewage systems) that have profoundly transformed the natural hydrological dynamics of most river basins, natural ecosystems have been continuously and systematically exploited and forgotten (Ghetti 1993, Brils et al. 2008). Today there is an encouraging movement towards reconsidering the current "development paradigm". However, there is still a sizable gap to be filled before water resources can be managed more sustainably.

Rivers and water ecosystems are the primary unit of the natural water cycle. They alone can guarantee the natural regeneration of the quality of free-flowing water. This is a basic fact, and yet, today ecosystems are crushed by the overwhelming contemporary "development paradigm" (Beck 1988 and 1992). What would be the cost of generating good-quality water without rivers and water ecosystems? The concept of ecological valuation gives monetary value to the goods and services that mankind receives from well-functioning ecosystems (Papayannis and Pritchard 2011).

The section on traditional knowledge and techniques of past water civilizations will also form a central part of the museum. On a global scale, the reconsideration of traditional know-how can indeed play an important role in future water management planning strategies. For example simple but effective know-how related to social water management, rainwater-harvesting practices and solutions that prevented wasting of water in local cultures may prove to be more sustainable than some modern technological solutions (Beck 1988 and 1992; Ostrom 1990) (see Ch. 11 and 19). Traditional farming practices based on rainwater collection or sustainable groundwater use have a very different impact on the local environment than contemporary uses and approaches. When the focus is narrowed to consider only powerful modern technologies and the limitless exploitation of natural resources, the

FIGURE 13

Until a few years ago, the traditional *khettara* system (underground drainage channel) was used to bring drinking water to the Moroccan city of Marrakesh, but today most of these tunnels are in a state of total disrepair. Source: *Civiltà dell'Acqua* Photographic Archive.

obvious consequence – as evidenced across the Mediterranean Basin and the Middle East – is the depletion of non-renewable aquifers, groundwater salinization in delta areas and, for many small farmers, the loss of water rights (Shiva 2002). The case of a modern city such as Marrakesh, Morocco, is paradigmatic: unregulated pumping between 2003 and 2013 has lowered the aquifer by approximately fifty-five meters (Fig. 13).[15]

Modern technology can be ecologically devastating if specific rules to prevent excessive exploitation of water resources are not established. Solutions based purely on engineering and technological approaches may lead to ecological collapse if they are not nuanced with the notions of collective social responsibility and a sense of communal awareness of natural and environmental limits (Beck 1992, Ostrom 1990, Laureano 2003, Diamond 2004, Eulisse 2011) (see Ch. 9).

To reverse, wherever possible, the misconceptions and myopic misuses of water at a global level, and to inspire fresh ideas about sustainable water management, the structure of the museum has been conceived as a true "laboratory" for the experimentation and entertainment of younger generations, according to the principle of "learning by doing". Important sections devoted to the senses but also hands-on demonstrations will provide children with the space to play, explore and experiment with water. As such, the Water Museum of Venice will constantly bridge the gap between scientific research and the general public. A broad variety of displays, in the form of both permanent and temporary exhibitions, will highlight the unique features of sustainable ancient management models and show how they can strengthen and diversify current water knowledge.

Moreover, the topics covered in the exhibition area will be designed to stimulate research activities on "border issues" with a multidisciplinary and, if possible, interdisciplinary perspective, in order to go beyond the rigidity of individual disciplines and to inspire innovative and more sustainable water policies for the future.

Thus the Water Museum of Venice aims to show how innovative links and connections can be forged between past and present water knowledge. A stimulating confrontation with ancient management models requires a historic and anthropological approach that can reveal how water was considered and used in different water civilizations, according to functional, but also social, religious, and symbolic specificities. Dealing with ancient water perceptions from an anthropological perspective inevitably means reflecting critically on the commercial logic that has destroyed the intrinsic value of this precious resource. As such, the Water Museum of Venice can provide a new insight into the intrinsic cultural values of water.

Today, we have impressive means and a thorough knowledge at our disposal to solve the global water crisis by using integrated management practices which take into account the historic models that were perfected over generations. Traditional know-how has deeply influenced and modeled the environment and landscape we live in. By using this knowledge as a methodical instrument to inspire a renewed and more far-sighted management of modern technologies, institutional decisions and strategies aimed at planning a more sustainable future would provide a solid foundation for tackling the mounting water crisis we face today. The Water Museum of Venice may provide useful insights from the past to deal with these future challenges.

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ENDNOTES

1. Though it is difficult to provide a satisfactory definition of "traditional knowledge", this expression refers to practices which have been experimented with over the generations on a trial-and-error basis, and very often with sophisticated institutional mechanisms for the resolution of internal conflicts (Ostrom 1990, Reij et al. 1996, Laureano 2003).
2. See http://www.unizar.es/fnca/euwater/index2.php?x=3&idioma=en, accessed 1 March 2014.
3. As outlined from an anthropological perspective by Clifford Geertz (1973) and defined more recently by Vito Teti (2003), I will refer to the expression "water worlds" to indicate both the tangible and the intangible local heritage (i.e. hydraulic artifacts, such as works of engineering and architectonic evidences, but also legends, myths, rituals, and behaviors) that forged the specific assets of different water civilizations locally.
4. See http://www.unesco.org/new/en/venice/special-themes/h2ooooh-initiative/h2ooooh-initiative-drops-of-water/, accessed 1 March 2014.
5. The term "canal" will be used here to refer to historic, artificial man-made canals, while the word "waterway" will be used with reference to the merging between natural and artificial watercourses (including the system of connections between rivers and canals).
6. "The Most Serene Republic", a reference often found in Venetian chronicles about the city.
7. Without "hydraulic highways" such as the Battaglia Canal, Venice would have looked very different today. Indeed this canal has for centuries been the main route for the transport of Euganean volcanic stone, so-called trachytis. This grey stone was used as paving throughout the city.
8. Responsible Tourism along European Historic Waterways was an international workshop held in October 2012 in Venice and Battaglia Terme (Padua, Italy), to develop new transborder cooperation for sustainable ecotourism along Europe's historic waterways.
9. See www.civiltacqua.org, accessed 1 March 2014.
10. 2011 saw a record 22 million visitors to Venice (source: APT of the Venice Province). Taking an average of at least two bottles per tourist, one arrives at the estimated total of 40 million plastic bottles.
11. The level of chemical parameters provided by Italian law for tap and fountain water, as stressed by Altamore (2008), is much stricter than that of bottled water.
12. Many ignore the fact that water contained in PET bottles is often exposed to damaging sources of light and heat, above all in summer, irredeemably compromising its quality. This is why Italian law obliges producers to display on all labels a warning to keep the bottle "in a fresh, dry, clean place free from odors and away from sunlight, sources of heat and cold."
13. Venetian squares.
14. See note 3.
15. See www.iwa-traditionaltechnologies2013.ma, accessed 1 March 2014.

KEYWORDS: HÉRAULT, WATER ARCHIVES, WATER GOVERNANCE

Abstract

Like water, archives are a common good that must be passed on to future generations. This principle was affirmed by the French Revolution with the creation of an organizational system that granted every citizen free access to this documentation. Today, the Hérault Departmental Archives, which were also created during this period, cover 1000 years of history. In this collection that constitutes 35 km of parchment, paper and other materials, our challenge is to identify the documents related to water and to protect and disseminate this heritage.

The example of the Hérault area provides the key to understanding the French archival system. It also shows how the archival system has had to deal with private appropriation and the fragmentation of water stakeholders, highlighting the need to safeguard the archives in order to ensure better management and equitable sharing of this precious resource.

2. Water Archives, a History of Sources:

The Example of the Hérault in France's Langueoc-Roussillon Region

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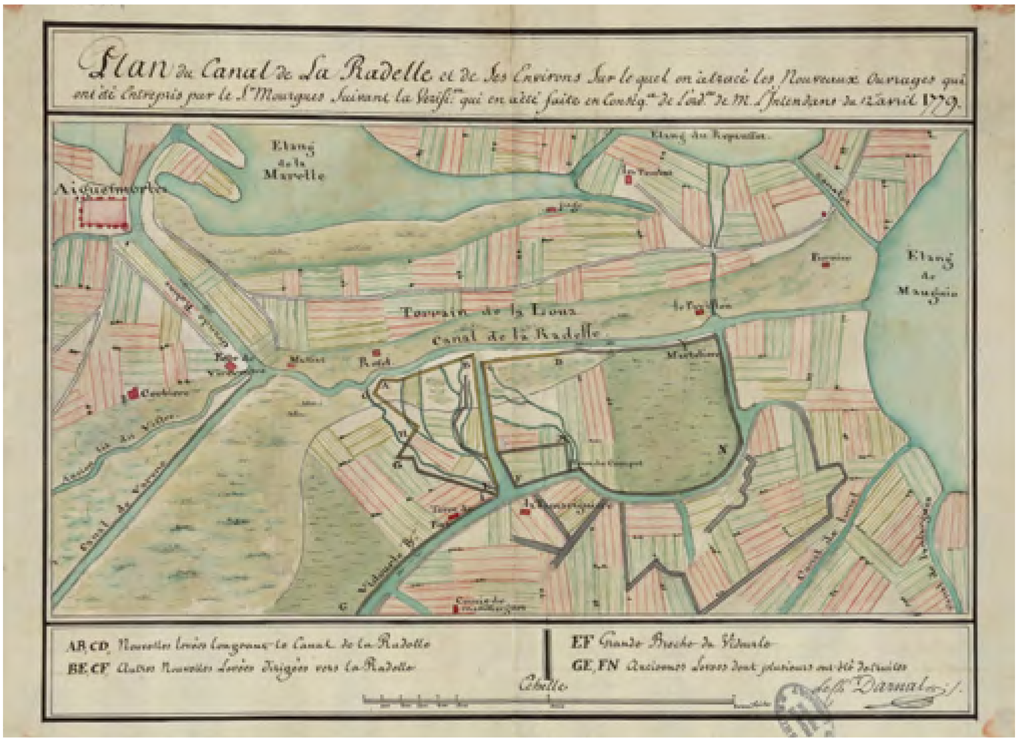
INTRODUCTION

Water history archives allow us to gain an understanding of the development of landscapes, how water flows through them and alters its course with changing climatic conditions. It also gives an insight into the historic uses of this precious resource and the refined systems of water sharing that have been developed over the centuries. This documentary heritage thus forms an essential basis for the development of sound water management systems today, particularly in Mediterranean countries where scarcity is increasingly putting pressure on water resources.

The aim of this article is to show that the identification of water archives at the level of the French *département* is linked to the state governance system. This has led to the creation of a very centralized archival system, which is today being challenged by a variety of public-sector stakeholders.

FIGURE 1



Between Aigues-Mortes and Mauguio (Languedoc, France): development of the lowlands (here river flood control works) at the instigation of the Intendant in 1779. Source: Archives de l'Hérault, C 5779.

The sources of water history in the *Département* of Hérault

To identify sources of water history, one must first be familiar with the organization of archives in France, which is modeled after the administrative organization that was created at the time of the French Revolution.

Water history archives allow us to gain an understanding of the development of landscapes and how water flows through them.

THE ORGANIZATION OF PUBLIC ARCHIVES IN FRANCE

A centralized and hierarchical system modeled on the administrative organization (law of 7 messidor year II, 25 June 1794):

- National archives (Paris): archives of institutions whose jurisdiction extends across the country (ministries for example)
- Departmental archives (law of 5 brumaire year V, 26 October 1796): archives of institutions that have been devolved from the state and that function on the level of the *département*
- Municipal archives: the archives of a town or municipality

1789-1964, a centralized governance system and a rigid administrative framework

The old system of provinces was abolished with the French Revolution. The powers exercised by the Intendant and the Provincial Estates were transferred to the départements.[1] Along with the archives of all the other institutions that had been dismantled, these provincial archives were collected at the chef-lieu (the administrative center of a *département*), which was the city of Montpellier in the case of the Languedoc. Thus documents related to water management before the

FIGURE 2

The gorges of the Hérault River near Ganges (Languedoc, France) in 1809: the prefect aims to build a mill here. Note the mulberry trees on the banks that supplied the silk factories. Source: Archives de l'Hérault, 7S34.

revolution (series C of the departmental archives) are now stored in the departmental archives (Fig.1).

From the time of the Empire until 1982, there were few changes to the administrative framework: the prefect at the head of the *département* and his team implemented state water policy, including water resource development and the monitoring of use (Fig. 2).

The municipalities – the last level in this administrative triptych (state, *département*, municipality) – are traditionally responsible for the drinking water supply. Their records are either stored in the municipalities or in the departmental archives (Fig. 3).

However, certain communities managed to by-pass this administrative framework. For example, water users from two municipalities in the Hérault developed a joint water management system in the Middle Ages to administer the parcels of land that were created after the drainage of the lake of Montady near Béziers. This management system continues to function to this day under the form of an association, and its records are kept by the current president of the association (Fig. 4).

Later, Authorized Syndical Associations (water user associations), like the one created in 1879 to manage the irrigation canal built along the Hérault River, presented another form of governance that sidestepped the regular administrative framework. The association's archives take up an entire room at the head office, where they are stored in relatively good order.

The reorganization of water management since 1964

From 1964 onwards, two trends have profoundly altered the way in which water archives are created (Richard and Rieu 2009):

FIGURE 3

A fountain in a Mediterranean village in the early twentieth century, before the arrival of running water. Source: Archives de l'Hérault 2FICP_01667.

FIGURE 4

The lake of Montady near Béziers (Languedoc, France) was drained in the thirteenth century following a circular plan, creating a striking landscape that survives today. Photo: V. Miguet.

FIGURE 5

From the late nineteenth century, the irrigation canals on the banks of the Hérault River are managed by a water-user association. Source: Archives de l'Hérault, 5K 383.

- On the one hand, the introduction in 1964 of the basin concept and the new approach to water management it entails. Multi-stakeholder water management structures are created in the framework of these basins, known as CLE or local water commissions made up of state representatives, local elected representatives, and users (1992 water law).

- On the other hand, in 1982, certain responsibilities that previously lay with the state were transferred to the local authorities with the decentralization laws. Thus the region gradually replaces the *département* as the main state representative.

This has far-reaching consequences for water management records (Balsamo et al. 2011):

- The departmental archives are no longer the only source of archival production in the area.

- A large variety of organizations are involved in the collection of historic water documents so that the literature surrounding water history is scattered.

These new institutions have unstructured archival systems, with little to no organized services, no trained staff, and no classification system. As a result, documents are more difficult to access. Researchers and water historians who are used to finding all documentary resources grouped together in the national or departmental archive centers must not overlook the numerous other sources of documentation. New forms of access to information are also taking shape with the online publication of digital resources, which will allow much broader access and sharing of data, even beyond the organizational structures of individual countries.

Translation: Francesca de Châtel

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ENDNOTES

1. Pre-revolutionary France was made up of about twenty provinces, which emanated from the medieval principalities vested in the Crown. With the Revolution, these provinces were broken up into 89 *départements*, based on the principle of local administration and governed by a representative of the state.

3. Meander(ing) Multiplicity

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KEYWORDS: MEANDER RIVER, MEANDERING, METIS, *MÊTIS*, CULTURAL IMAGINATION

Abstract

The Meander River (Anatolia, Turkey) once formed a conduit between Europe, North Africa, and Asia. Herodotus mentions the Meander's winding ways and Strabo gave us the meaning of meandering as wandering. In the modern era the river has all but disappeared from the cultural imagination and meandering has acquired a negative connotation: the opposite of goal-oriented efficiency. I trace the various trajectories of the Meander and show how in the 21st century meandering has gained renewed significance, both in its riverine and metaphoric capacities. It resonates with new approaches to innovation and creativity in science, technology and policy: wandering to elucidate attributes, relations, problems, and solutions. It reflects the ancient Greek notion of cunning intelligence, *mêtis*, in its sense of resourcefulness, practical effectiveness and experiential wisdom. Meandering can be of pertinence for understanding the multiple-mediated mosaic of the Mediterranean.

INTRODUCTION

The Meander River (Anatolia, Turkey) once formed a crucial conduit for Mediterranean trade and traffic between Europe, North Africa, and Asia. At its mouth sat the foremost Aegean port city Miletus, acclaimed for the origins of Greek philosophy and science. Historians Herodotus and Strabo mention the Meander's winding ways, which were so striking that "meander" came to mean riverine sinuosity and to stand for anything twisting and curving. It even became the name for an ornamental pattern. However, while the word carved itself deep into the cultural imagination, the river slipped out of that imagination. The Meander River – the Büyük Menderes River nowadays – is, outside Turkey, a little-known river; the fact that the word and phenomenon of meandering refer to a real existing river is all but forgotten.

The geomorphological process of meandering is as intricate, twisting and turning as the curving Meander River. A meandering river takes time while it covers a broad area, scouring the hardest rock, depositing the quickest sands. It is deeply spatial, temporal, and specific – continually finding its trajectory, while making it. It is profoundly responsive to the lay of the land, the nature of the climate, the character of human interventions, and a multitude of other vectors. In fact, so many factors and processes are at play that there is, as yet, no precise explanation as to why and how rivers meander. Neither is there a conclusive standardization in the description of meanders: a variety of scientific symbols, parameters, theories, models and schemes are employed.

Symbolically and metaphorically, meandering conveys the multifarious and capricious nature of the sinuous. It bespeaks the often-unpredictable movements of coming and going, the curving back and forth. The emergence and fading of the Meander River in the cultural imagination can itself be seen as a meandering: an appearance and disappearance of the very river that left its indelible mark on human culture by giving its name to the process in which it disappeared again. The self-referential character intensifies the complexity of the process. In hydrological and geomorphological sense, as well as metaphorically, meandering is clearly a complex process.

Linearity has become the privileged paradigm of progress, its leading model of efficiency. In the modern imagination meandering has a negative connotation. The straight line signifies progress, an arrow moving forward and upward over time, symbolizing growth and improvement through the control of nature. Its concomitant mindset is goal-oriented or teleological. Seen from this perspective, meandering has become a metaphor for aimless wandering, ambling along a winding path, or rambling through a long-winded argument. Convoluted and seemingly undirected, meandering is seen as not just the opposite of the efficiency of 'streamlined' operations—but as standing in the way of efficiency.

However, most practices develop in sinuous ways: learning through mistakes, honing a skill, experience built up over time in a never-ending process. Furthermore, most systems are nonlinear and unstable in nature. In the course of the second half of the twentieth century this became widely accepted in the sciences – including physics, mathematics, and engineering. The weather is a good example. In fact, study of the weather played an important role in the development of nonlinear dynamics. Miniscule changes in one part of a weather system can have complex effects throughout the system, which makes accurate long-term weather forecasting impossible, at least with current modeling techniques. Chaos theory, and non-deterministic as well as stochastic non-linear modeling became the state of the art in many fields, including research into the behavior of large-scale natural or social systems in ecology, economy and politics. Chaos is not the same as randomness; rather, it means that change produces complex effects that are not exactly predictable. Analyses of both practices and systems highlight the importance of field-dependency, of a larger context. A growing awareness of these dynamics opened the door towards a widespread acceptance of complexity in the cultural imagination and, as I explore here, a revaluation of meandering.

Valuing meandering will have a train of effects on various concepts and practices. It facilitates a different way of thinking about efficiency, acknowledging that it might be more efficient to take more time and explore various possibilities, just as a river meanders through a basin. Meandering privileges exploration: a messy process, with stumbling, learning from failures, following contingent relations, a going back and forth. Exploration drives innovation, more than control does. Meandering foregrounds the searching in the notion of re-search. It invokes a model of engineering in terms of ingenuity, a bricolage and tinkering that acknowledges and interacts with various kinds of knowledge and expertise, that is capable of adjusting itself to local situations and demands, instead of simply following the straight lines of rule-driven reasoning. Meandering resonates with the ancient Greek notion of cunning intelligence, *mêtis*, in its sense of resourcefulness, practical effectiveness and experiential wisdom.

Meandering implies a very different sense of efficiency and progress - it allows for a re-thinking of progress through complexity rather than through linear order. Meandering invokes, elucidates, and hints at another practice, a different way of knowledge, another mindset, a different imagination, and a cultural and political framework that diversifies what counts as expertise, progress and efficiency.

Here I explore the potential power of meandering as a concept, a metaphor and a form of *mêtis*, for approaching complex issues around the Mediterranean. It bespeaks the political and social necessity of going back and forth, taking time to explore the terrain, to elucidate attributes, relations, problems, and solutions, as a gateway to new constructs of imagination, to a capacity to aspire. Meandering does not allow for simple analyses or reductionist geopolitical frameworks. Meandering connects flows of words with flows of water and flows of power, bringing the social, technological, and natural together in a moving pattern of ongoing political deliberation, doing justice to the rich sociocultural history of the region.

The Mediterranean calls for a mosaic of writings – multifarious, with a wealth of cultural traditions, ecosystems, and intricately layered events, stories, and histories. I set this conceptual model into motion, allowing the discrete tiles of a mosaic to show their overlapping entanglements, their changing configurations over past and future. I expand the Mediterranean mosaic metaphor into one of meandering movement by exploring the various trajectories of the notion of meandering, back and forth, in and out of the cultural imagination. I will start with its relation to the ancient Meander River, follow some of its symbolic trajectories, such as the relation to the Meander pattern and Metis, and conclude with that which underlies this whole essay: the never-ending value of meandering.

THE MEANDER RIVER MEANDERING

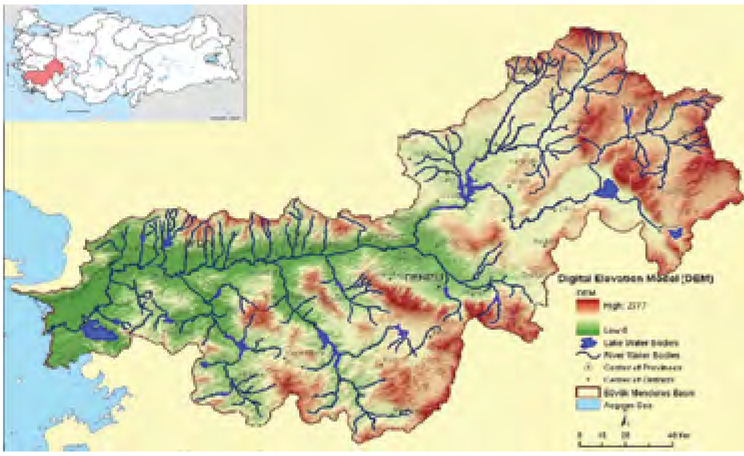
The Meander River, currently the Büyük Menderes River in southwestern Turkey, courses through the southwestern part of what the Greeks called Anatolia and the Romans, Asia Minor. The Greek *Ανατολή*, like the Latin terms "Levant" or "Orient," means the "East" or literally "sunrise". Originating in southern Phrygia, now west-central Turkey, the river flows west to the Aegean Sea, where Miletus, the southernmost of the Ionian cities, was the major harbor. It is a rather short river (584 km long), with a relatively small modern-day population in its basin of 2.4 million. It is a predominantly rural area, with agricultural production of cotton, figs, olives, and chestnuts, and animal husbandry of cattle, sheep, and goats (Fig. 1).

The earliest mentions of the Meander are found in Homer and Hesiod between approximately 750 BC and 650 BC. The Homeric tradition has deep Ionian roots and Hesiod's ancestors also came from the western coast of Asia Minor; his father was from Cyme in Aeolis. Both mention the Meander in passing, in a list of other names. Hesiod gives a mythological account, relating how the river is named after one of the sons of the Titans Oceanos and Tethys: *Μαίανδρος* (Maíandros), a name variously rendered as Maeandrus, Maeander or Meander. "And Tethys bore to Ocean eddying rivers, Nilus, and Alpheus, and deep-swirling (...) Strymon, and Meander, and the fair stream of Ister" (Hesiod 1914: 337ff.). According to Hesiod, Tethys and Oceanus had three thousand sons. They were all river-gods or *Potamoi*. Hesiod only mentions the foremost of these by name, such as the Euphrates and Tigris, the Ister (nowadays called the Danube) and the Meander. Hesiod continues to tell us that Tethys and Oceanus also had three thousand daughters, the Oceanids, each of them patroness of a specific natural entity such as a spring, river, or lake.

FIGURE 2

Pouqueville, "milet et cours du Meandre". Source: Firmin Didot frères, 1835. Personal copy of lithograph.

FIGURE 1



Map of Büyük Menderes River. Büyük Menderes River Basin Management Plan, T.R. Source: Turkish Ministry of Environment & Forestry, 2011.

FIGURE 3

Statue of Achelous by Simon Marière (1684-88). Photo: Vincent Torri, 2011.

Among the few that were named explicitly, are Tyche (Fortuna in Latin) and Metis, both of whom we will encounter later.

Homer mentions the Meander in his historical and geographical account in the Iliad. After the main characters from the Greek side are introduced, a catalog of the Trojan troops follows. Near the end of the list we find the Meander: "And Nastes again led the Carians, uncouth of speech, who held Miletus and the mountain of Phthires, dense with its leafage, and the streams of Maeander, and the steep crests of Mycale." (Homer 1924: 870).

The expression "uncouth of speech" is revealing: those Carians from Miletus and the Meander Valley are rude, foul-mouthed, ill mannered and uncultured. In Greek it is expressed in the single word: *barbaroi (βαρβαροφώνων)*, literally, the "non-Greek speaking," that is, they are the "others," which clearly implies, inferior.

Not long after the accounts of Hesiod and Homer, the Greeks settled the Ionian Coast including the Meander Delta. The Meander Valley became a vital trading route for Mediterranean and Asian goods. One might call this the first meandering of the Meander River in the cultural imagination. After the negative portrayal of the river in Homer, it became the precious gateway to the east: "vast caravans of wood, wheat and spices, marble and ivory" followed its course, as Seal (2012: 11-12) notes in his well-researched Meander River travelogue.

Not only traded goods, but also armies traveled the basin. The city at the headwaters of the Meander River, Dinar (Celaenae in the fifth century BC), was of strategic importance: its pass formed the gateway between East and West. Xerxes' Persians headed west in 481 BC to conquer the Greeks and Alexander the Great (from Macedonia) headed east to conquer the Persians 150 year later. These classic power shifts between the East and the West kept meandering along the river that gave the process the name.

Near the Meander's mouth on the Aegean Sea was the prosperous port of Miletus, the southernmost of the Ionian Cities. In the course of the sixth and fifth centuries BC it was a cultural center, booming and bustling with celebrated musicians, poets, engineers, mapmakers, and philosophers such as Thales, Anaximander, and Anaximenes (Fig. 2).

Aristotle called Thales of Miletus the first Greek philosopher, no longer a theologian like the old poets, but the founder of natural philosophy. Thales considered water to be the beginning, an originating and guiding principle or *archê*.

Water is crucial for food production. Like many rivers, the Meander provided excellent conditions for agriculture, a great advantage for the traffic of military and merchants. Its valley was a valuable hinterland for the city, providing a steady food supply. River gods *(potamoi)* were often represented holding a cornucopia, a horn of plenty, the symbol for providing abundance, and bringing bounty. Fortuna (Tyche in Greek), one of their sisters, often carried a cornucopia too. As the goddess of chance, fate or even capriciousness, unpredictability, changeability, she could bring many goods. Or withhold them. Similarly the river could give and take. In the cultural imagination rivers and fate occupied a similar position (Fig. 3 and 4).

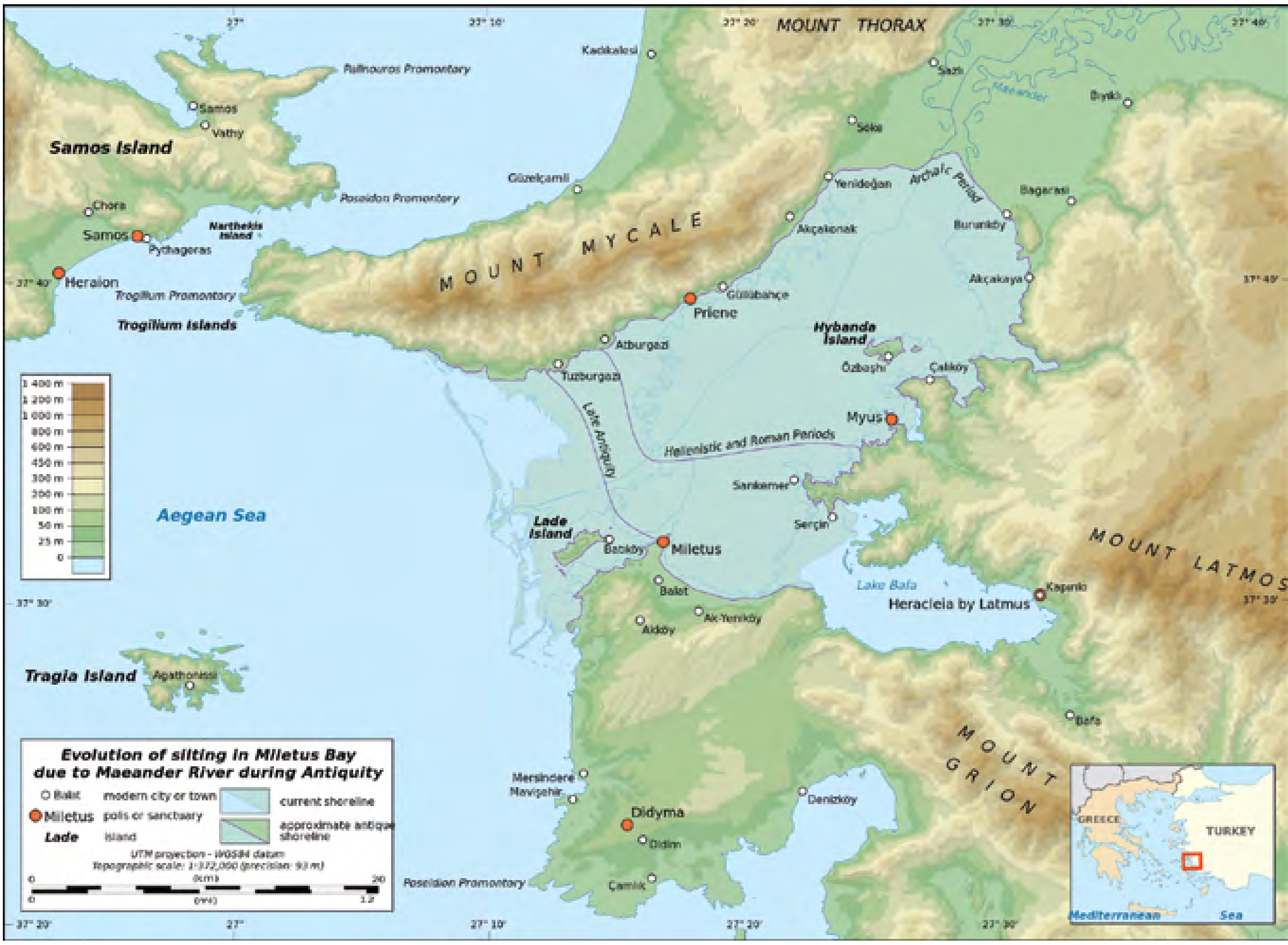
FIGURE 4

Statue of Fortuna, Roman copy of Greek original, Museo Chiaramonti. Photo: Sailko, 2010.

The very same agricultural development that had been so advantageous for the Meander Valley traffic enhanced erosion and silt formation in the Meander River basin. In another meandering of history, Miletus became a landlocked town. Over the centuries, the Miletus Bay silted up with alluvial deposits from the very river that had made it important.

The economy of the once-prominent harbor city collapsed. Nowadays, the ruins of the city lie some 10 km from the Aegean Sea (Fig. 5).

FIGURE 5

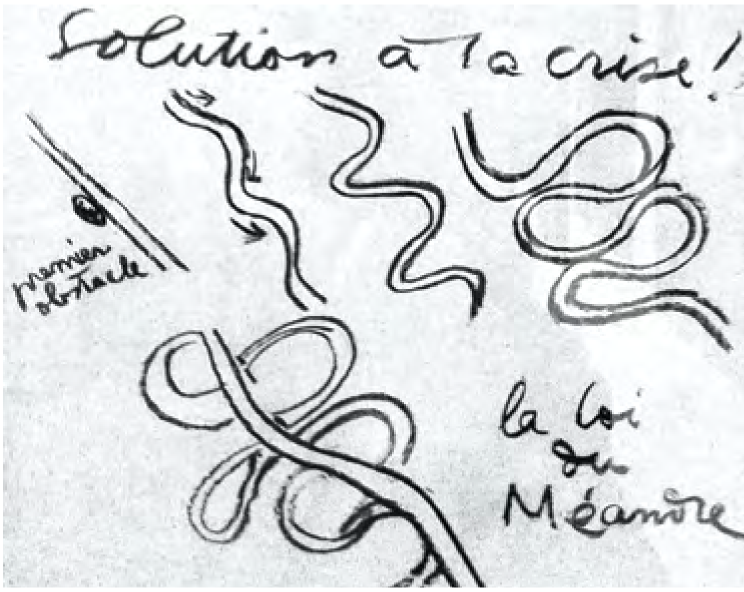


Map showing the evolution of the silting of Miletus Bay. Source: Eric Gaba, 2009.

STRABO AND LE CORBUSIER'S LAW OF THE MEANDER

Two thousand years ago Strabo, in his *Geography,* described the course of the Meander at its beginning as an easy-going stream, then becoming a large river flowing through Phrygia, then forming the boundary between Caria and Lydia. At this point the Meander is so crooked[1] that everything that is winding is now called "meander." Strabo was the first to explicitly indicate the metaphoric force of the Meander River. The ambivalence of the phenomenon is expressed in the different translations of *scolios*, varying from sheer descriptive to evaluative: "torturous." Even if the word *scolios* might have been a neutral description of the phenomenon, the river did not acquire any glorious or pleasant adjective. Over time *scoliosis* became the name for a medical condition, a deformity of the spine, where it no longer follows a straight line but looks like a "?" or an "S." *Scoliosis* is something in need of correction, certainly when pain is involved. Strabo's *scolios* cast a long shadow over meandering rivers.

FIGURE 6



A sketch by Le Corbusier, adapted from *la loi du Méandre*.
Source: Le Corbusier 1991: 142.

For centuries the meandering of rivers has been associated with something to be straightened out, often in the name of efficiency. At the same time meandering kept capturing the cultural imagination. Even *the* architect of the straight line, Le Corbusier, was fascinated by meanders. So far did his fascination go that he 'discovered' the Law of Meander, which ultimately straightened the curves once again.

In 1929 Le Corbusier was invited on the inaugural flight of the South American Aviation Company from Buenos Aires to Asuncion in Paraguay in a tiny ten-seater plane. The co-pilot was no less than Antoine de Saint-Exupéry, the author of *The Little Prince*. Le Corbusier was fascinated by the delta of the Parana River, one of the world's major rivers, at the confluence with the Paraguay River. He marveled at the very geomorphology of the meandering rivers and took the meandering as a metaphor for human thinking. He suddenly realized that wandering and changing often underlie human creative thinking, human dealing with the problems of life as it is lived in the real world. "Following the outlines of a meander from above, I understood the difficulties met in human affairs, the dead ends in which they get stuck and the apparently miraculous solutions that suddenly resolve apparently inextricable situations" (Le Corbusier 1991: 4). He developed a Law of the Meander that largely concerned itself with "breaking through" or stratifying the meander, rather than having the structure and experience of meandering inform "knowing how." Despite his fascination with the form, Le Corbusier's Law of the Meander privileged the straight over the sinuous (Fig. 6).

MEANDER KEY MOTIF

The Meander motif was – and still is – frequently used to symbolize the sinuous river flow in highly stylized form. Whereas the meandering bends of a flowing river are all wildly different in shape and form, the highly stylized representations in the Meander key motif are precisely and equally stratified. In some ways one could see this as a reduction of the inherent complexity of meandering. Numerous temples were decorated with the motif; it formed a border decoration on many a wall, vase, rug, bath, and floor.

The meander pattern flows through much of human culture. More than 15,000 years ago it appeared in Upper Paleolithic ornamentation (Fig. 7) and we still see frequent use of meander patterns in contemporary public architecture, clothing, and jewelry. Striking archeological specimens were found at the palace of Philip II of Macedon (fourth century BC): a well-preserved mosaic floor (Fig. 9) and, perhaps most spectacularly, the Ivory Shield found in Philip's tomb (Fig. 8).

The meander has taken another historical loop that links Philip's shield to the present. Philip II of Macedon and his son Alexander the Great loom large in the cultural imagination that underlies the so-called 'Macedonian naming dispute,' which broke out after the breakup of Yugoslavia in the early 1990s. The main bone of contention

FIGURE 7

Upper Paleolithic armlet of ivory with rafters and meanders, Mezin (18,000-15,000 BC). Source: Gimbutas, 1995.

FIGURE 8

Ceremonial shield of Philip II of Macedonia in Vergina, formerly Aigai, first capital of Macedon. Photo: Adapted from *LIFO* LightBox, Manolis Andronikos.

FIGURE 9

Restored mosaic pattern on palace floor in Vergina. Source: Adapted from alaxandramosaics.

is the use of the name Macedonia by the newly formed Republic of Macedonia. Adjacent Greece argues that the ancient Kingdom of Macedon fell mainly within its territory and not within the Republic of Macedonia. The inhabitants of the latter are ethnically speaking Slavic people, that is to say not Greek; rather like Homer's *barbaroi* from the Meander River region. This invoked strong nationalistic sentiments and the Republic of Macedonia was accused of appropriating symbols and figures of traditional Greek culture. The far-right nationalist political party in Greece, the Golden Dawn, plays in on the nationalistic imagery, espouses racial purity and venerates Nazi figures and policies. They adopted a flag featuring a meander pattern on a red background clearly reminiscent of the Nazi *swastika*,[2] itself adapted from a good luck symbol used for millennia in many cultures.

A line of *swastikas* yields a meander pattern and a meander pattern is easily visually broken into a string (one is tempted to say 'stream') of good luck symbols. When the German Nazi Party adopted this good luck symbol, the connotation changed dramatically. The complex ways of the good and the auspicious in politics were reduced to a xenophobic rhetoric of purity. Golden Dawn renews such simplicity with its use of the meander and sutures that rhetoric of purity directly to the heart of their claims by looping back to Philip II.

Golden Dawn's politics is one of simplifications, reductions of a complex world to simple certainties in which Greek identity and Greek nationalism become reduced to xenophobic and racist exclusions of non-Greeks, not only Slavs, but also immigrants from other Mediterranean regions, particularly those of African and Middle Eastern descent. A xenophobic rhetoric of the purity of the nation resonates with a population under stress, especially in difficult economic times (see Ch. 10). In the 2012 Greek national elections Golden Dawn received 7 percent of the popular vote, enough to give them 21 (of the 300) seats in the Hellenic Parliament.

MEANDERING AND METIS

The very twisting and wandering character for which meandering became so well known bespeaks a way of thinking long ignored, belittled, even considered counter-productive, precisely because it connotes complexity and multiplicity instead of unity. In its polymorph character, adjusting itself to the circumstances, meandering is structurally comparable to the ancient Greek notion of applied or real-world intelligence, *mêtis*, conveying a similar sense of resourcefulness and practical effectiveness.

FIGURE 10

Winged goddess thought to be Metis, in a scene depicting the birth of Athena. Detail on black-figure amphora (550-525 BC) in the collection of the Louvre, Paris. Photo: Marie-Lan Nguyen.

In Greek mythology Metis *(Μῆτις)* was a female deity, daughter of Oceanus and the first spouse of Zeus. She represented wisdom, skill, craft and cunning, a highly praised combination. Fearing her powers and her offspring, Zeus swallowed her, but she had already conceived Athena, who was born fully armed from his forehead. Metis symbolized cunning intelligence in politics, practice-based knowledge in military art and medicine, the skills of the artisan crafts; all these forms of experiential wisdom were called *mêtis*. (Fig. 10).

In their masterful work, *Cunning Intelligence in Greek Culture and Society*, Detienne and Vernant argue that mêtis is "at the heart of the Greek mental world in the interplay of social and intellectual customs where its influence is sometimes all-pervasive" (1978: 3).

However, despite its pervasiveness, *mêtis* is never explicitly thematized or analyzed. While there are many treatises about logic, there are none about *mêtis*. The intellectual world of Greek philosophy, in contrast to the everyday mental world, was a dualistic world with a radical dichotomy between being and becoming, the intelligible and sensible, the unchanging one and unstable multiple. In this framework of thought there was no place for *mêtis*, which "is characterised precisely by the way it operates by continuously oscillating between two opposite poles" (Ibid.: 5).

Odysseus is celebrated as the wily cunning, the *πολύμητις*, the one of many counsels, (literal translation: *πολύ* "many" *μητις* "*mêtis*"). But the nature of his cunning, or of the skills of a craftsperson, the problem-solving of a detective, the art of making a good joke, even the "Eureka moment," went largely unexamined for centuries. *Mêtis*, often defined tersely as "craft, skill, and experiential wisdom" came to stand for knowing how, for the palette of abilities outside the logical, goal-directed, static ways of knowing of logos.

Mêtis escapes simple definition – it "always appears more or less below the surface, immersed as it were in practical operations" (Ibid.: 3). Its way of knowing, its kind of intelligence and "its field of application is the world of movement, of multiplicity and of ambiguity. It bears on fluid situations which are constantly changing and which at every moment combine contrary features and forces that are opposed to each other" (Ibid.: 20).

"The essential features of *mêtis* ... – pliability and polymorphism, duplicity and equivocality, inversion and reversal – imply certain qualities which are also attributed to the curve, to what is pliable and twisted, to what is oblique and ambiguous as opposed to what is straight, direct, rigid and equivocal" (Ibid.: 46). Detienne and Vernant mention explicitly the term *skoliós* in this context, as one of the adjectives indicating curving, frequently used to describe *mêtis*; the same term Strabo used to describe meandering.

MEANDERING THROUGH SOLUTION SPACE

The Meander confounded early lawyers concerned with boundaries and scientists concerned with the mechanisms of meandering streams. Meander symbolized irregularity, complexity, ambiguity, and instability. In the latter part of the twentieth century precisely these 'meandering' qualities brought out the value of multiple perspectives in arts and sciences; the weak ontology of becoming became as valuable as the traditionally more privileged strong ontology of being; the inductive, analogical, and emergent as valuable as control and generalizability (O'Connor and Copeland 2003: 99). The understanding of probability and complexity provided new forms of explanation and new ways to operate even within fields long founded on 'ideal' characteristics and laws. The meander came to be seen as an irregular waveform, at once subject to and generating random processes and forms.

Similarly, recent writers have begun to characterize emergent and analogical thinking. These characterizations of ingenuity bear deep resemblance to the *mêtis* of antiquity. Dreyfus speaks of *expertise* in terms of "intuition [that] is the product of deep situational involvement and recognition of similarity" and notes: "how experience-based holistic recognition of similarity produces deep situational understanding" (1986: 29, 32). Similar concepts characterize modern ingenuity and engineering design: explicitly pragmatic; contingent; visual in character; satisficing; messy; holistic; whimsical; learning from failure (O'Connor and Copeland 2003:104).

Hapgood describes the first phase of engineering design as a "metaphorical traversal through solution space," in which "failure, imagination, and stuckness" are at play. The traversal and design process is "idiographic and unpredictable" and often beset with "painful trials or iterations." For Hapgood the engineer is a "tinkerer who engages in activities within an artistic and subjective context" (Hapgood 1993: 96). O'Connor and Wyatt use the term "thinkering" to blend Hapgood's tinkering together with Dreyfus's deep situational involvement into "engineering discovery by doing" (O'Connor and Wyatt 2004: 12).

"Allowing the mind to wander aids creativity," asserts science journalist Kaplan in his report on recent research by psychologists Baird and Schooler. Their study suggests that "simply taking a break does not bring on inspiration – rather, creativity is fostered by tasks that allow the mind to wander" (Kaplan 2012).

So we see *mêtis* acknowledged as a set of habits of expertise and the Meander holding its metaphorical power for today.

CONCLUSION: RE-MEANDERING

In, a so-called "feat of reverse-engineering" a research team at the University of California at Berkeley built a scale model of a living meandering gravel-bed river in their lab. It was the first successful model ever. A National Science Foundation report notes: "Stream restoration is an extremely complex and delicate science. Because there is no formula to create meandering streams. Successful stream restorers almost require a sixth sense to get everything right and set a sustainable environment into motion, and not every restored stream lasts" (Deretsky 2009).

Re-meandering has become a popular practice in ecological restoration, even in places where there never were meanders. Rivers are resurfacing in the public imagination as cultural and ecological corridors, creating a cultural rejuvenation around urban renewal projects. In many rural areas river restoration is underway: the re-meandering of watercourses and restoring of floodplains are being carried out by many of the same engineering firms that straightened the waterways in the early or mid-twentieth century. New management regimes are seeking to work with, not against, rivers.

Meandering is never finished – not even in the delta where the river and the sea meet and co-create the sweet-salt interface, an extremely fertile ecosystem. As Leonardo da Vinci stated: "In rivers, the water that you touch is the last of what has passed and the first of that which comes…" (Cremante 2005: 246). The river keeps flowing. A river is never finished. It is part of a large system of tributaries, groundwater flows, evaporation and precipitation flows. The term "hydrological cycle" suggests too simple a process.

Meandering continues to have metaphorical and illustrative power, not just for classicists or hydrologists. In the early twenty-first century it is a notion of importance for describing complex phenomena. The *BBC* used "meandering" extensively to indicate the phenomenon of the Jet stream, elucidating the major dips in the jet stream caused by changes in differential pressures encountered by the stream; it is used neither pejoratively nor positively, it just is (Ghosh 2014).

Meandering is dependent on the complex interaction of many material vectors. It is a symbol for how power operates in the everyday, lateral traversing, picking up material and depositing, re-activating in the process. Meandering stands for an ethics of adjustment, a politics of engagement, enabling and ongoing deliberation, a sense of experiment: tinkering, thinkering, emergent and transient. Meander brings the social, political, technological and natural together in an ongoing dynamic. The Law of the Meander is not the straight line but the sinuous back and forth, symbolized linguistically by the prefix 're-', the notion of the again and again, not as a Phoenix emerging from the ashes, completely burnt, but in the sense of honing a skill, the experience one gets in *mêtis*, the exploration through wandering, the essay in Montaigne's original sense of trial and attempt.

Meandering is a slower process than the straight line of progress, covering more ground, percolating into deeper depths, listening to the murmurs of more voices. Meandering makes room for what cannot be measured, what does not want to be measured, for the slow: slow food, slow movement, slow design, for the workings of the material realm not ruled by the structures of scheduled time.

The Meander River no longer functions as a Mediterranean thoroughfare, but the notion of meandering to which it gave rise has endured, and has re-emerged as valuable. Meandering is not a symbol for closure but one of ongoing change and exchange, of identities that shift over time. As Stuart Hall wrote: "Cultural identities come from somewhere. But, like everything which is historical, they undergo constant transformation. Far from being eternally fixed in some essentialised past, they are subject to the continuous 'play' of history, culture and power" (1994: 396).

Meandering can be of pertinence for understanding the multiple-mediated mosaic of the Mediterranean. The region is not served with simple solutions; they do not do justice to the specificities of Stuart Hall's continuous 'play' of history, culture and power. Meandering is a metaphor for the ongoing necessity of debate and negotiation in politics, a metaphor that cannot be reduced to a simple geometrical symbol, or hijacked by an extremist political party. Meandering bespeaks *mêtis*, the shape-shifting intelligence, which enables us to aspire to a complex future.

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ENDNOTES

1. σκολιότητας, rendered by Hamilton and Falconer in 1903 as "torturous" and by Jones in 1923 as "exceedingly winding".
2. *Swastika* is derived from Sanskrit for "it is good or auspicious."

4. A Spanish Water Scenario

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FIGURE 1

The "New Water Culture" advocated by local communities and academics has become increasingly influential.

An estimated 80 percent of Spain's available water is used in the agricultural sector. Source: David A. Nafría, 2010.

KEYWORDS: WATER SCENARIO, WATER POLICY, WATER SCARCITY, SPAIN

Abstract

The new global models for integrated and environmentally sustainable water management, such as the European Union Water Framework Directive, are generally designed to support local, regional or national political interests. Wherever water is scarce, as in the Mediterranean Basin, it lies at the center of political struggles. In this respect, water is closely related to the practice of democracy, as I will illustrate through the example of Spain.

INTRODUCTION

Most international institutions and agencies, environmental organizations, and many governments develop water policies on the basis of scientific and technical models, which draw on two principal vectors: development and environmentalism. Historically, water policies were driven by a desire for development, with the implementation of large-scale hydroelectric and irrigation projects, the diversion of rivers and the construction of dams in many countries. This was also the case in Spain. However, from the 1980s onwards, social movements, political parties, scholars, and experts developed new ideas and started critiquing the government's *Política Hidráulica*, pointing to the far-reaching social and environmental impact of these mega-projects. This social movement became more influential after the Spanish government issued its National Hydrological Plan in 2001, which triggered a broad-based and powerful opposition throughout Spanish society. The plan included a 1 billion cubic meters/year water transfer from the Ebro River to the Mediterranean coast, a highly controversial plan that sharply divided political parties and public opinion. When the new socialist government came to power in 2004, it immediately canceled this National Hydrological Plan.[1] During the period between 2000 and 2004, water policy had become a central issue in Spanish politics and these events clearly demonstrated that the traditional model of the *Política Hidráulica*, which had inspired the water transfer and other large-scale water projects, was no longer viable in the late 1990s and early 2000s. Instead, new global water management models emerged, which brought environmentalism into the mainstream. According to this model, water management should be considered in the broader context of the environment and conservation. Water use for social and economic development had to conform to these environmental requirements. Today many countries have integrated these concepts into their water legislation, but it remains to be seen whether water policies and management can really be environmentally sensitive. I explore this question using the case of Spain.

In Europe, the most relevant environmentally sensitive water management model is the European Union (E.U.) Water Framework Directive issued in 2000. The main goal of this directive is to achieve a "good ecological status" for all European surface waters by 2015 and to establish a common European water policy. One of the core concepts developed in the directive is the "good status of water".[2] In Spain, social movements and academics who had opposed the traditional *Política Hidráulica* welcomed the directive, as they had always defended the environmentalist principles contained in it. At the other end of the spectrum, certain political parties, hydroelectric companies, farmers' unions and even some regions that had supported traditional Spanish water policy based almost exclusively on large-scale engineering works, had to accept this new directive and adapt to it.

WATER SCENARIOS

While previous development models were articulated around the centrality of water, the E.U. Water Framework Directive and other integrated water management models currently in use are based on the concept of contextualization. This new perspective marks a fundamental change in the current definition of water policies. The concept of centrality meant that the productive uses of water determined the priorities of this development model, which incorporated not only water, but also public works, investments, profits, laws and institutions, as well as ideologies, culture and even myths.[3] All sectors had to be organized around the exploitation of water (irrigation, hydroelectricity, navigation, drinking water etc.) in order to create new benefits for society. This enormous challenge was founded on an ideological and cultural proclamation related to concepts such as the reclamation of deserts (Spain), the colonization of a promised land (U.S.A., Israel) or the creation of the "New Man" in a socialist society (U.S.S.R). By contrast, the environmentalist principle incorporates a holistic view, recognizing that water cannot be separated from its ecological context. It is based on ideas of conservation, restoration, cost recovery and good status. The transition from the development model to the environmental model defines Spain's current water policy in a somewhat paradoxical manner. It is what I call a "water scenario".

To explore the concept of the scenario further, I will draw on my ethnographical experience in researching water issues. The practice of fieldwork shows that what is described in many reports, conferences, discourses, theoretical propositions and institutional documents does not always match events in the field. In Spain, the most recent environmental, integrated water policy model is rarely implemented, even though it is recognized and accepted by all parties and stakeholders. Instead, the main ideas of the *Política Hidráulica* are still deeply rooted in some parts of Spanish society. This could be interpreted as a common situation in which the old resists the arrival of the new. In fact, this kind of interpretation has often been used to explain historical changes that have transformed many societies and is especially significant from the point of view of Marxist theory. We are also reminded of the old saying: "Everything must change so that everything can stay the same." Without rejecting these interpretations, I will argue that the current integrated water policy models are not as factual or scientific as they purport to be. They exist more on paper than in practice and could, in the future, become an excuse for the development of new bureaucratic apparatuses.

The question is, what is actually happening? The use of a "water scenario" strategy must take us to a particular place and recognize what happens there. A "scenario" is a comprehensive and holistic methodology that does not depend on a previous, closed and imperative model to define the real but instead engages in a cultural analysis to understand what is happening. Social anthropology is a suitable discipline to apply to the study of water issues because its main goal is the study and understanding of human diversity. A "scenario" is a space and time in which different parties interrelate in terms of their similarities and differences around a relevant subject matter. Water is one of those relevant subject matters. Since a cultural analysis is especially capable of identifying and comparing any discursive construction, and considering that water policies have to confront a very antagonistic world of ideas, traditions, interests, visions of the future and narratives, its application to a "scenario" can provide good insights for understanding how water is managed and which water policies are being implemented in each case.

THE SPANISH WATER SCENARIO

My description of a Spanish water scenario will present ten key points, which show how many interrelated aspects come together to form a water scenario. This complexity demands a strong interdisciplinary approach, which the E.U. Water Directive unfortunately does not have. Its basic conception is biological or even "biologistic" and tends to ignore social science perspectives. The directive's notion of the environment is almost exclusively biological, which impoverishes its conception of a water policy.

1. Water imbalance and transfers

According to the *Política Hidráulica* model, some basins have water surpluses, which flow into and are "lost" in the sea, while others experience shortages. Hydraulic planning should seek to correct these imbalances. The only way to achieve a good balance is by transferring water from surplus basins to water-scarce ones. In the 1990s, these arguments were used to justify the construction of interbasin transfer infrastructures, and this argument became central to water policy discussions in Spain at the turn of the twenty-first century, generating intense social and political conflict. Criticism of this principle has been a central argument for all people opposing water transfers and there is an ongoing discussion about the methodological value of concepts such as water surplus and deficit, and the data used to calculate them. The Tagus-Segura diversion, constructed in the 1970s, is the most important water transfer system now operating in Spain.

2. Irrigation

An estimated 80 percent of Spain's available water is used in the agricultural sector. There is an ongoing debate about the quality of agricultural produce generated on large areas of irrigated land and its economic viability given that farmers receive significant government and E.U. subsidies. On the other hand, farmers have invested considerably in irrigation modernization, abandoning traditional flood irrigation methods in favor of water-saving sprinkler and drip techniques (Fig. 1).

3. Desalination

Spain has about nine hundred desalination plants, mostly on the Mediterranean coast, with a total capacity of 1.1 billion cubic meters/year. After the cancellation of the Ebro River water transfer project to the Mediterranean coast in 2004, Spain's new socialist government supported the AGUA plan to build fifty-one desalination plants to replace the 1 billion cubic meters/year that the Ebro water transfer would have provided. Spain's arid Mediterranean coastal region has a large population, a highly developed tourism industry and a thriving agricultural sector that focuses on the large-scale production of fruit and vegetables under intensive irrigation. The AGUA plan has been a failure due to the high cost of desalinated water, which makes it unaffordable for use in the agricultural sector. Today the seventeen plants in operation produce less than 100 million cubic meters/year. Desalination remains controversial due to its cost, environmental impact and high energy consumption. In addition, some critics argue that desalination merely offers another supply-side solution, whereas answers should instead be sought in the improved management of demand. This argument states that Spanish water policy has historically always focused more on supply than demand management and that the fundamental approach thus needs to be modified.

4. Water pricing and markets

There is an ongoing debate about pricing as a way of encouraging water saving, and also about the introduction of cost recovery for the new hydraulic infrastructures following the prescriptions of the 2000 E.U. Water Framework Directive. Surface water is a public good in Spain, which can only be used for profit by societies, companies, communities or individuals by means of administrative concessions and for a declared use. The last reform of the 1984 Water Act permitted the sale of water if its final application did not change the approved use of the original concession. There are some who favor a total liberalization of water markets and their extension as a way of rationalizing water use and preventing waste. This is, of course, a very controversial view. A revision of concessions and the reform of the concessionary system have been proposed, but this is bound to be highly controversial in its application.

5. Water conflicts

In the last thirty years, Spain has decentralized its political structure and the Autonomous Communities have gained competency in water policy making. This process has however triggered a confrontation between the inland and coastal communities over future and current water transfers. For example, while the Community of Castilla-La Mancha demands an end to the Tagus River water transfer, the Mediterranean regions remain firmly opposed to such a move.

6. Public participation and contestation

A number of social movements that have sprung up in the last 30 years offered resistance to the plans of the Spanish water sector and several consecutive governments. These social movements were created by local populations affected by new dam schemes and also by scholars and experts, most of them from the academic world, who have encouraged protest and opposition to a number of new hydraulic projects (dams and water transfers). While the importance of public participation in water management has finally been recognized, more needs to be done to take public opinion into account in the formulation of new policies. The new approach to water management that is advocated by local communities and academics is now termed the "New Water Culture" and has become increasingly influential.

7. Reform of the water administration

Spain was one of the first countries to introduce river basin management, with the creation in 1926 of the *Confederación Hidrográfica del Ebro* (Ebro River Water Authority), which gained complete control of water management in the Ebro River basin (Fig. 2). However, nearly a century later, these management units (*Confederaciones Hidrográficas*), which were traditionally controlled by hydraulic engineers, are in need of substantial change. While they have to date mainly acted as promoters of public works such as dams, canals and pipelines, they should now focus on the implementation of a more integrated and interdisciplinary water management policy.

FIGURE 2

Rivers and river basins of continental Spain. Source: Ministry of Agriculture of Spain; Adbar, 2013.

8. Drought

Drought is a structural part of Spain's mainly Mediterranean climate. But while it is a regular occurrence, it remains difficult to implement a water policy that integrates a drought-preparedness strategy. Instead, periodic droughts have become part of a political struggle. They are used to gain votes with the promise of immediate and expensive quick fixes such as pipelines or water transfers, which are useless when the drought ends. However, if maintained they can be used for the following drought.

9. Partisanship

In the last two decades, water issues have been used so intensely for political purposes that the positions of the main political parties – often very emotional and influenced by localism and nationalism – seem irreconcilable. However, water policy is so important for Spain that its basic foundations should be outside the domain of everyday political confrontation and considered a bipartisan issue. Unfortunately we are far from such an arrangement.

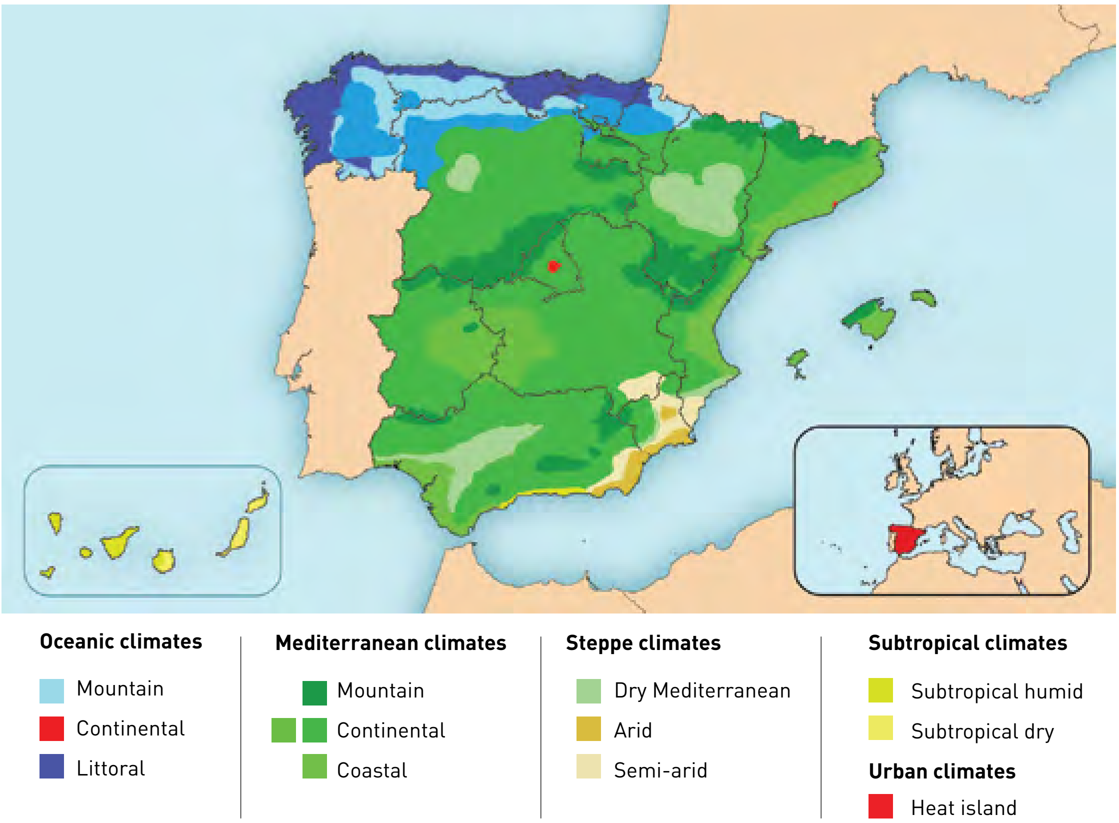
10. The 2000 E.U. Water Framework Directive

The implementation of the E.U. Water Framework Directive has become a serious problem. The directive is based on an environmental conception of water and does not pay much attention to the concept of linking water and development. The ideas of conservation, recovery and good ecological status are some of its key points. Spain's water policy still focuses on demand and is subject to great historical inertia.

FROM POLICY TO POLITICS

This brief overview shows how environment, economy, technology, society, politics and culture are closely related. This relationship is complicated, as many stakeholders with diverse and at times antagonistic interests interact around water. We need a better understanding of these antagonisms. Water management then becomes a cultural issue and its understanding demands local knowledge because the diversity of water experiences is not only determined by ethnic or regional differences, but is also an example of people's cultural valuing of water. This culturalization of water is especially significant in regions where water is scarce and becomes the axis of social and political dynamics.

FIGURE 3



Climates of Spain. Source: Galjundi7, 2011.

Today, integrated management is fast becoming the new model for water policies. It is roughly defined in the following terms: "The integrated water resources management approach helps to manage and develop water resources in a sustainable and balanced way, taking account of social, economic and environmental interests. It recognizes the many different and competing interest groups, the sectors that use and abuse water, and the needs of the environment" (GWP and INBO 2009: 10).

If we understand integrated water resource management in these terms, we can appreciate that rather than a model, it is a methodology that takes us more into the realm of politics than policy. This is what happens when we move from the analysis of a water policy model designed by international organizations to a local, regional, and even national level where we find water scenarios. The Spanish water scenario is a kind of playing field in which history, ideologies, political interests, regional cultures, and identities all play important roles. In order to succeed, water policy models should therefore take these particular scenarios into consideration.

The roots of any water policy lie in politics and require a democratic approach to water management.

Though Spain is also an Atlantic country, our water scenario is Mediterranean since it is mainly defined by the status of water resources in its water-scarce Mediterranean regions (Fig. 3). In fact, droughts are the triggers that periodically activate and intensify these water scenarios. Water becomes ideological, even mythical and the interests of all stakeholders compete with each other. Water policy models are used in as much as they offer arguments for or against competing interpretations. The main objective is to win.

I cannot see how water policies in Mediterranean Europe can ever be simply technical problems to be solved by better science and technology – even though both are of course essential. The roots of any water policy lie in politics and demand a democratic approach to water management.

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ENDNOTES

1. Instead, the new socialist government decided to build fifty-one new desalination plants with a total production capacity of 800,000 cubic meters per year.
2. According to the E.U., "good status" refers both to the ecological and chemical state of water resources.
3. For more on this see Mairal, 2010.

5. Transboundary Management
of the Hebron/Besor Watershed in Israel and the Palestinian Authority

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KEYWORDS: TRANSBOUNDARY WASTEWATER TREATMENT AND REUSE, HEBRON/BESOR WATERSHED, STONE-CUTTING SLURRY WASTEWATER, ISRAEL, PALESTINIAN AUTHORITY

Abstract

Untreated wastewater generated upstream in the West Bank flows downstream into Israel causing environmental and health concerns, as well as exacerbating the conflict between Israelis and Palestinians. This article reports on the first transboundary watershed-based wastewater management and reuse project that is being implemented in the Hebron/Besor watershed. The project offers an alternative to other inefficient unilateral action, which fuels the conflict rather than resolving it for the benefit of the communities living in the area and the environment. The article discusses water-quality monitoring in the Hebron Stream and describes the multiple sources of wastewater in this area, which has a large quarrying and stone-cutting industry.

INTRODUCTION

Around sixteen streams in Israel are transboundary in nature or shared between Israel and the Palestinian Authority, with roughly two thirds originating in Palestinian territory, flowing through Israel and discharging into the Mediterranean Sea to the west. Lack of cooperation between Israel and the Palestinian Authority means that these waterways are all highly polluted, preventing their agricultural, recreational and ecological use. Past experience shows that effective restoration of Israel's streams requires a coordinated effort between Israelis and Palestinians. If one side invests in infrastructure to control pollutants, but the other continues to pollute, this will have no meaningful impact on the regional environment. However, to date such coordination has been minimal and cooperation is difficult. The main objective of this article is to lay a foundation for the effective restoration of the region's transboundary streams by promoting and implementing the concept of transboundary watershed management. The paper argues that as all of Israel's water resources (surface and groundwater) are transboundary, Israeli and Palestinian water policy should center on a transboundary approach to watershed management.[1]

In principle, most water experts in Israel and the Palestinian Authority recognize the need to adopt watershed-based approaches to water management, acknowledging that rivers, wetlands and groundwater provide important ecological services such as waste assimilation, floodwater storage, and erosion control and that these services provide additional social and economic benefits, such as improved water resources for domestic, agricultural, and recreational use. The ongoing Israeli-Palestinian conflict makes the adoption of watershed-based approaches difficult but not impossible.

Israeli and Palestinian water experts have for decades cooperated on transboundary water issues, although this cooperation has been mainly technical or research-based. Because water does not recognize political borders, it can only be effectively managed on the level of the hydrological watershed, through, for example, the implementation of a basin-wide master plan. Based on ecological, historical, physical, economic, and geographical terms agreed upon by both sides, such a master plan serves the best interests of the watershed, regardless of present or future political issues.

TRANSBOUNDARY WASTEWATER CONFLICTS

Drought, population growth and rapid agricultural, industrial, and commercial expansion have widened the gap between water supply and demand in Israel and the Palestinian Authority. Israel has bridged this imbalance by developing sophisticated technologies to increase water supply through desalination and wastewater treatment and reuse, while Palestinian infrastructure, technology, and investment lag behind. West Bank Palestinians experience frequent water shortages and the treatment and reuse of wastewater are very limited. The Palestinian Authority's centralized wastewater collection networks do not service the majority of residents: 73 percent of the population relies on cesspits (Fischendler et al. 2011), in contrast to Israel where less than 10 percent of the population is not connected to the sewage network. The poorly maintained septic tanks and cesspits used by most Palestinian households act only as holding tanks. Cesspits do not have an outlet and do not treat the sewage appropriately. Their function is to collect and store wastewater until it is emptied and disposed of.

Sewage stored in cesspits is either untreated or only partially treated and thus poses a major risk to human health since sewage contains waterborne pathogens that can cause serious illness such as cholera, typhoid, and dysentery. Untreated sewage can also destroy aquatic ecosystems and thus threaten human livelihoods when the associated Biological Oxygen Demand (BOD) and nutrient loading deplete oxygen in the water to levels too low to sustain life. Generally the cesspits in the West Bank are unlined, allowing the inadequately treated sewage to percolate into and pollute the groundwater, which is an important source of drinking and irrigation water for both Israelis and Palestinians. Most cesspits are emptied with vacuum tankers that dump untreated sewage in open areas or in wadis, thus polluting the environment and constituting a public health risk. Roughly 60 million cubic meters of raw sewage is discharged into the environment in the West Bank every year (Fischendler et al. 2011). Much of this sewage flows from the upstream areas in the West Bank, across the Green Line[2] and into the downstream areas in Israel.

Conflict occurs primarily around the Green Line at the point where the sewage from the West Bank crosses into Israel. According to Israeli law, the country is obliged to treat the sewage, but has no right to use it, as the water belongs to the Palestinians according to international law. Israelis demand that the Palestinians treat their sewage, but the Palestinians counter that they are unable to do so as Israel hampers their ability to build the appropriate treatment facilities. Another aspect of the conflict occurs in Area C[3] where Israel proposes to build wastewater treatment plants that will serve both Israeli settlements in Area C and Palestinian communities. Palestinians refuse to consider such a proposition, as this would entail their recognition of the settlements which are deemed illegal according to international law and the international community. Nonetheless, there are a few cases in the West Bank where Israeli settlements and Palestinian communities share a treatment facility.

When the cesspits are not emptied in time, sewage overflows posing serious environmental and public health risks, and contributing to the cross-border conflict. As raw sewage flows downstream, it harms Israeli attempts to rehabilitate surface and groundwater sources. Palestinian inability to treat the sewage hampers the development of the Palestinian agricultural sector as recycled wastewater could form an additional source of irrigation water in the West Bank.

There are three specific sources of conflict over wastewater issues between Israel and the Palestinian Authority (see also Ch. 14):

- Location and construction of treatment facilities
- Cost and benefit sharing
- A lack of bilateral water-quality standards for reuse in irrigation.

Firstly, the location and construction of wastewater treatment facilities is a source of conflict between the parties due to the division of the West Bank into Areas A, B, and C (according to the Oslo II accords[4]) and unilateral actions by both parties. As wastewater treatment facilities should be removed from population centers, usually the most suitable location for the Palestinian Authority to build the plants is the mostly rural Area C. However, all construction in Area C requires recognition, special arrangements, and licensing from the Israeli Civil Administration as well as a permit from the Joint Water Committee,[5] normally an arduous bureaucratic process.

Disagreements often occur when the permit process is delayed, permission is denied, or Israeli military orders halt project implementation. The Palestinian response is to focus on options that can be carried out in Area A where Israeli approval is not needed. However, the dense urban nature of Area A makes it difficult to find an appropriate site for the construction of a wastewater treatment facility. Additionally, rather than implement joint ventures as originally envisaged by the Oslo process, Israel has built several treatment plants on the Israeli side of the Green Line that capture the sewage flowing from the upstream regions of the West Bank. These facilities treat 33 percent of Palestinian urban wastewater (Al-Saed 2010), but are inefficient, non-integrated, and inferior to at-source upstream treatment solutions. This unilateral Israeli move has sparked ardent protests from the Palestinians, who cannot use the treated wastewater, which is instead discharged and used downstream in Israel.

Secondly, wastewater crossing political boundaries leads to disputes over cost and benefit sharing. Treatment plants in Israel operate according to a "polluter pays" principle. Israel deducts the cost of treating Palestinian wastewater at Israeli facilities from jointly collected Palestinian custom and trade taxes before transferring the remaining funds to the Palestinian Ministry of Finance. Over the past 15 years, Israel has charged the Palestinian Authority more than $34 million in reimbursements for wastewater treatment (Al-Saed 2010). The Palestinian Authority objects to the offset and claims that these deductions, which are not supported by bilateral agreements, are illegal. Furthermore, the Palestinian Authority does not receive any of the economic and environmental benefits of the treated effluent – most importantly the return flow for irrigation. In some cases, Israel uses reclaimed Palestinian water for irrigation purposes and river rehabilitation, as is the case with the Alexander River in northern Israel. The Palestinian Authority demands that Israel deducts the value of these benefits from the offset treatment costs. In general and as discussed above, Israel cannot use reclaimed Palestinian water under international water law. Rather, Israel treats the wastewater – mostly at a minimum primary level of treatment – and then discharges it unused into rivers. Collaborative efforts could thus yield significant benefits for both parties in terms of additional water for irrigation, stream and river rehabilitation, and the protection of groundwater resources from pollution.

However, the two parties would have to sign a treaty before treated effluent could be exchanged for additional extraction from the Mountain Aquifer,[6] and water allocations and use would have to be clearly spelled out. Israel and Jordan have signed such a treaty regarding allocation of the Jordan and Yarmouk Rivers, but no such treaty exists between Israel and the Palestinian Authority. As the Palestinian Authority is not a sovereign state, it cannot enter into a formal treaty with Israel. The only agreement between the parties, the Oslo Accords, was designed as an interim accord, not a treaty. It does discuss water allocation of the Mountain Aquifer between the parties, but does not cover the allocation of treated wastewater or options for an exchange scheme.

Finally, the "polluter pays" principle has triggered further disputes, with Israel insisting that the Palestinians adopt Israeli wastewater treatment and reuse standards. These standards, known as the Inbar Standards,[7] require all wastewater treatment plants to treat wastewater to a tertiary level for unrestricted use in irrigation. Many facilities in Israel currently treat wastewater to secondary level and are required to upgrade their facilities to tertiary level. The Palestinian Authority insists that paying for treatment of their wastewater according to Israeli standards is unfair, especially when they do not get to use the treated wastewater for irrigation. This unilateral approach to water quality standards further exacerbates the conflict as Israel makes unreasonable demands on the Palestinians regarding the level of wastewater treatment they should implement. As the Palestinian Authority has a very limited wastewater treatment capacity, it is unreasonable for Israel to require treatment to tertiary level in compliance with the Inbar Standards.

CASE STUDY: Transboundary restoration of the Hebron/ Besor watershed

The Hebron/Besor watershed covers about 3,500 km^2, stretching from the semi-arid region of Hebron in the West Bank and Beer Sheva in the Israeli Negev Desert in the east to the Gaza Strip in the west (Fig. 1). The Hebron Stream originates in the Hebron Hills in the West Bank, crossing the Green Line and flowing into the Israeli city of Beer Sheva where it receives water from tributaries in Israel's northern Negev (such as the Beer Sheva Stream), and ends in the Gaza Strip on the Mediterranean coast (Wadi Gaza). The basin is characterized by many land uses: urban, rural, industrial, agricultural (both crop and livestock), grazing, firing ranges, and open spaces.

Located in a semi-arid to arid region, the streams in the Hebron/Besor Basin are naturally seasonal and water may only flow in the streams six to seven times a year during the rainy season (winter floods). However, today untreated effluent creates a permanent base flow that has profoundly altered the nature of these streams. Around 5 million cubic meters of untreated effluent from domestic, agricultural, and industrial sources in the West Bank is released into the Hebron Stream annually and crosses the Green Line into Israel where it flows westward and is joined by additional effluent from Israeli agriculture and communities.

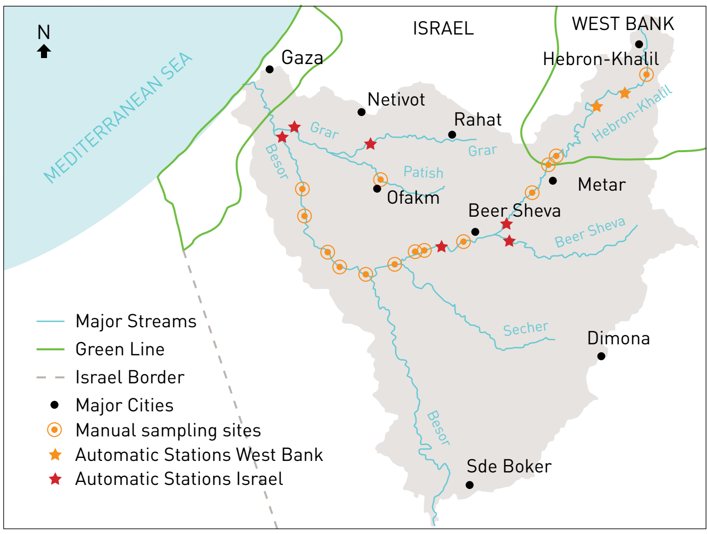
Pollution continues to threaten these streams, as the ongoing conflict between Israel and the Palestinians stands in the way of a watershed-based approach to stream management.

Since the 1990s, the untreated wastewater of the Palestinian city of Hebron and the adjacent Israeli settlement of Qiryat Arba (combined population: approximately 200,000) is released into the Hebron/Besor Stream. In addition to domestic wastewater, the stream also drains the wastewater of nearly 100 industrial facilities. These are mostly small Palestinian marble and stone-cutting plants in the Hebron region.

Preliminary results

This case study discusses a project that is ongoing, and the research has not yet reached the stage where any conclusive results about the state of the watershed or specific recommendations about its restoration can be reported. However, significant progress has been made in the data-gathering phase of the project.

FIGURE 1



The Hebron/Besor watershed. Source: Ghazal Lababidi after Arava Institute for Environmental Studies, 2013.

FIGURE 2

The sheep of Bedouin herders drink from the polluted Hebron stream in the West Bank. Photo: Clive Lipchin, 2013.

Water-quality monitoring

In order to rehabilitate a stream, sources of pollution must first be identified and then removed. Pollution can originate from point sources, i.e. flowing directly into the stream from a single source, or from non-point sources, i.e. flowing indirectly into the stream from diffuse sources. Non-point source pollution is more difficult to identify and regulate than point source pollution. Nevertheless, over the last fifteen years non-point source pollution loads in streams have decreased by 50-80 percent in Israel. Similarly, point source pollution sites have decreased from 130 to 80 sources. This is largely due to daily on-site supervision, inspection and enforcement. These improvements have largely taken place thanks to the introduction of the Inbar Standards mentioned above.

However, despite Israel's efforts to improve water quality in streams, pollution from the

Palestinian Authority continues to cross the Green Line. Israel does not have the jurisdiction to enforce the Inbar Standards in the Palestinian Authority and the wastewater infrastructure in the Palestinian Authority is woefully inadequate (Fig. 2). The result is that large amounts of point and non-point source pollution enter the streams that flow from the West Bank into Israel, such as the Hebron/Besor Stream. The ongoing conflict between Israel and the Palestinians does not allow for the adoption of a watershed-based approach to stream management, with the result that pollution continues to threaten these streams. This project is the first of its kind to adopt a watershed-based approach to stream restoration with water-quality monitoring occurring throughout the watershed (Fig. 3). As the Inbar Standards provide an unprecedented number of quality parameters that set a maximum allowable discharge limit, we have used these standards as our baseline to determine pollution levels in the Hebron/Besor Stream.

The Inbar Standards also impose various obligations, including monitoring and sampling plans to control wastewater effluent discharge, recording and reporting requirements for effluent quality, increased transparency to the public and the publication of monitoring results.

We chose four water-quality monitoring sites, two in the West Bank and two in Israel. The first site is on the outskirts of Hebron, the largest city in the West Bank and in the watershed; the second site is near the Green Line in the southern West Bank; the third site is at the entrance of the Bedouin town of Tel Sheva in Israel just east of Beer Sheva, and the final site is west of Beer Sheva near to Kibbutz Hatzerim. The choice of these sites allows for the comparative assessment of water quality in the Palestinian and Israeli areas of the watershed, as well as before and after the Beer Sheva River Park.[8] The monitoring took place in June 2013.

FIGURE 3

Water-quality sampling in the Hebron Stream in the West Bank. Photo: Clive Lipchin, 2013.

TABLE 1

Parameter	Unit	Inbar Standards, discharge to streams	Upper catchment, West Bank (outskirts of Hebron)	Meitar checkpoint (southern West Bank)	Tel Sheva (east of Beer Sheva)	Near Kibbutz Hatzerim (west of Beer Sheva)
pH		8.5	7.91	8.19	8.31	8.67
Electrical Conductivity (EC)	mS	2.2	2.19	2.35	2.40	2.24
Chlorine (Cl)	mg/L	250	247	252	348	411
Bromine (Br)	mg/L	0.4	0	0	0	0
Sodium (Na)	mg/L	150	196	208	287	285
Phosphate (PO_4)	mg/L	5	0.877	1.092	1.139	0.969
Chemical Oxygen Demand (COD)	mg O_2/L	100	1210	1230	186	170
Total Suspended Solids (TSS)	mg/L	10	1260	2721	62.0	63.0
Ammonium (NH_4)	mg/L	20	2.860	2.965	0.760	0.550
Fluorine (F)	mg/L	2	35.8	18.6	0	0.73

Water-quality monitoring results for the Hebron and Beer Sheva Streams. Source: Field samples gathered and analyzed by the Arava Institute for Environmental Studies, Israel, June 2013.

Table 1 indicates the results of the water-quality monitoring. The highlighted rows show that there is significant pollution along the whole course of the stream, specifically in terms of sodium, Chemical Oxygen Demand (COD) and Total Suspended Solids (TSS). These parameters are well above the Inbar Standards for wastewater discharge to streams, highlighting the low quality of the water in the stream. As a water quality parameter, the COD value is commonly used to indirectly measure the amount of organic compounds in water. In the case of the Hebron/Besor watershed, the COD values are orders of magnitude higher in the West Bank than in Israel, indicating more untreated wastewater is released in the watershed in the West Bank. The primary sources of pollution in this case are most likely the stone-cutting, leather-tanning and olive-oil industries in the Hebron region. TSS is a measure of the amount of suspended particles in the water. Algae, suspended sediment, and organic matter particles can cloud the water, making it more turbid. Suspended particles can clog the gills of fish and once settled, it can foul gravel beds and smother fish eggs and benthic insects. In the case of the Hebron/Besor River, TSS values are orders of magnitude higher in the West Bank than in Israel, further underscoring the high level of untreated wastewater originating from industrial activities in the West Bank.

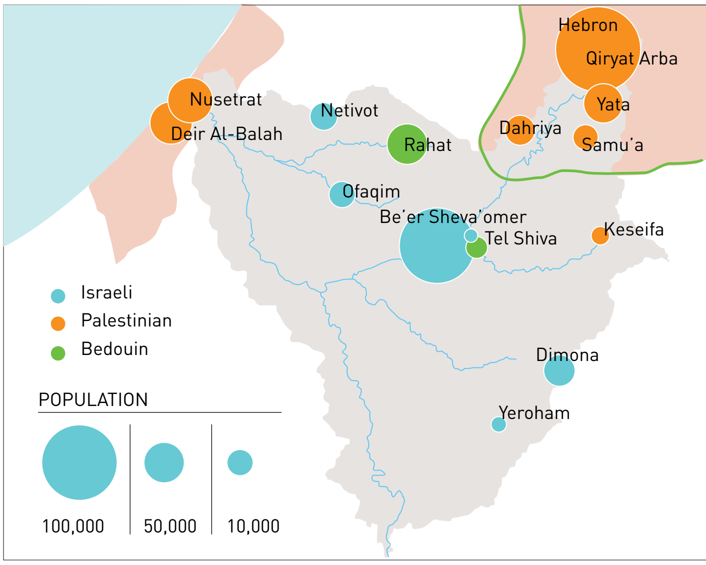
In summary, the table indicates a complex situation of point and non-point source pollution throughout the watershed, both in Israel and the West Bank. Three of the ten parameters do not meet the Inbar Standards, reflecting pollution along the whole course of the Hebron/Besor River, including the part that flows through the Beer Sheva River Park. In some places in the West Bank, the COD concentration exceeds the Inbar Standards values by orders of magnitude. The data is essential to understanding the water management situation in the watershed and providing a baseline for restoration. Further water-quality monitoring will include a comparison of the summer low-flow season and the winter high-flow season.

Socioeconomic characterization of the watershed

In 2010, the Hebron/Besor watershed had an estimated population of 647,167 inhabitants, with Bedouin, Israeli, and Palestinian communities. Figure 4 shows the spatial distribution of these population groups in the watershed. While most of the watershed lies in Israel, more Palestinians live in the watershed if one considers the Palestinian population in the West Bank and Gaza. The Bedouin community is the smallest population group. Figure 5 shows the population distribution in the basin based on 2010 census data and not including the Palestinian population in Gaza. It shows that nearly half of the population in the watershed is Israeli.

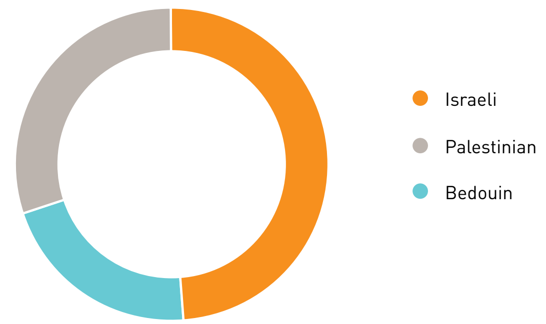
Figure 6 shows the differences in average annual per capita water consumption in the Bedouin, Israeli, and Palestinian communities in the

FIGURE 4



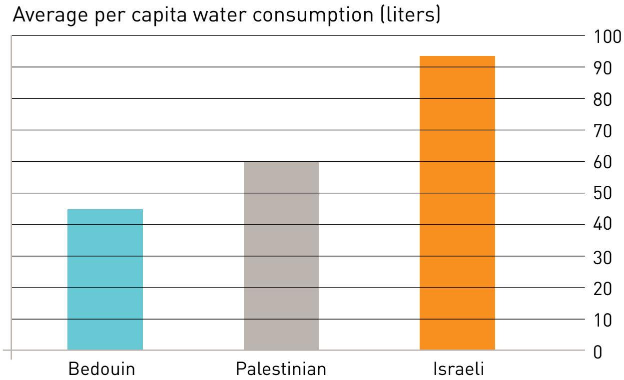
The size and spatial distribution of population groups within the Hebron/Besor watershed. Source: Arava Institute for Environmental Studies, 2013.

FIGURE 5



Population distribution in the Hebron/Besor watershed. Source: Census data from the Israeli Bureau of Statistics (2010) and the Palestinian Bureau of Statistics (2010).

FIGURE 6



Average per capita water consumption for Israelis, Palestinians and Bedouins in the Hebron/Besor watershed. Source: Census data from the Israeli Bureau of Statistics (2010) and the Palestinian Bureau of Statistics (2010).

watershed. The Bedouin population consumes the smallest amount of water (45 liters/capita), followed by the Palestinian population which consumes 60 liters/capita, while the Israelis are the largest consumers with 94 liters/capita. An in-depth socioeconomic analysis of the communities in the watershed that is currently being carried out aims to identify the reasons for the differences in water consumption. These may include socioeconomic factors such as employment, income, and family size, as well as technical factors such as the state of local water infrastructure.

Table 2 breaks down key population and water data for the main communities in the watershed. It reveals the complexity of the socioeconomic context in which water is consumed in the watershed.

This type of analysis is essential for the development of an inclusive watershed restoration strategy that involves and engages all stakeholders. As this project continues, further socioeconomic analysis will be carried out with the aim of achieving a balanced participatory process involving all stakeholders.

TABLE 2

Community	Type	Total Population	Total Water Consumption/ Year (1,000 cubic meters)	Per Capita Water Consumption (L/day)
Chura	Bedouin	17,500	554	31.66
Keseifa	Bedouin	17,400	615	35.34
Rahat	Bedouin	53,100	2089	39.34
Tel Sheva	Bedouin	15,700	732	46.62
Lakiya	Bedouin	9,900	564	56.97
Segev Shalom	Bedouin	7,700	493	64.03
Netivot	Israeli	27,500	1880	68.36
Dimona	Israeli	32,600	2556	78.4
Kiryat Arba	Israeli	7,200	583	80.97
Be'er Sheva	Israeli	195,400	16581	84.86
Ofakim	Israeli	24,200	2149	88.8
Lehavim	Israeli	5,900	546	92.54
Metar	Israeli	6,400	634	99.06
Yeruham	Israeli	8,300	905	109.04
Omer	Israeli	6,600	1059	160.45
Al Ubeidiya	Palestinian	10,753	N/A	56
Der Salah	Palestinian	3,373	N/A	59.5
Bet Sahour	Palestinian	12,367	N/A	60
Halhul	Palestinian	22,128	N/A	65
Hebron	Palestinian	163,146	N/A	70
Total Population		647,167		

Source: Census data from the Israeli Bureau of Statistics (2010) and the Palestinian Bureau of Statistics (2010).

Description of pollution sources in the Hebron/Besor watershed

Some of the most problematic sources of non-point source pollution that flows into the Hebron Stream originate in the upper catchment in and around the West Bank city of Hebron, where a number of local industries such as stone-cutting, leather-tanning and olive-oil production emit heavily polluted wastewater, which is released untreated into the local environment. The city of Hebron currently produces around 24,000 m^3/day of wastewater, most of which is not treated and eventually drains into the Hebron Stream (Al-Zeer and Al-Khatib 2000).

Stone and marble production

Based largely in the area of Hebron and Bethlehem, the stone and marble industry is of great economic importance to the Palestinian Authority, representing the largest manufacturing activity in the territories. The Hebron region has built a reputation for the production of high-quality stone and marble, particularly the world-famous Jerusalem Gold Stone. The industry has an estimated value of $400 million/year, creating between 15,000 and 20,000 direct jobs and many more in related areas. Stone- and marble-cutting activities account for 13 percent of non-agricultural employment, 5 percent of GDP, and hold 1,980 ha of land reserves for future quarries (USM 2011).

It is estimated that the stone-cutting industry uses approximately 0.5 million cubic meters of water per year and produces 3,300 metric tons/year of calcium carbonate solid waste (El-Hamouz 2010). The water is mainly used to cool the saws that cut the rock blocks. The water mixes with the dust to form a viscous liquid, known as slurry. It is estimated that the industry generates approximately 0.7-1.0 million tons of this slurry waste. Stone slurry waste contains heavy metals and suspension solids that vary within the range of 5,000 to 12,000 mg/L, which mainly consist of calcium carbonate (Al-Joulani 2011). The waste generated by the stone-cutting industry has accumulated over the years, as it has been dumped on open land, in valleys, and in sewage systems, causing extensive environmental and health problems (Al-Joulani 2008).

Every year, humans and animals die by drowning in open slurry waste ponds. Moreover, disposal of slurry waste on agricultural land causes a reduction of water infiltration, soil fertility, and plant growth. This practice negatively affects the fertility of the soil, contaminates the ground, increases drainage problems, and reduces groundwater recharge (Al-Joulani 2011).

Additionally, the slurry can clog pipes and block streams. For nearly a decade, slurry from the Hebron Industrial Zone was being released into the municipal wastewater system. Further downstream, in both the West Bank and Israel, Hebron's slurry was causing blockages, creating stagnant pools that attracted disease-carrying mosquitoes and rendered nearby crops useless due to the entry of the stone slurry into the Hebron/Besor watershed. It has been reported that the slurry has flowed into the intake area of the Israeli wastewater treatment facility near Beer Sheva, causing severe problems for the treatment facility as the plant was not designed to handle such a complex and unique pollutant composition (Kahrmann 2013).

The nature of the stone-cutting industry requires a significant amount of water for cooling and dust removal. While most of these enterprises recycle used water after passing it through on-site sedimentation tanks or basins, very few, if any, are connected to a sewage network. Most enterprises regularly drain the total content of the sedimentation tanks in nearby wadis, which can amount to 12 m^3/day of sediment (El-Hamouz 2010).

TABLE 3

Name of City/ Village	Total Municipal Area (km^2)	Contaminated Area (km^2)
Hebron/Al Fahs	43	1.052
Samo	27	0.254
Beit Ummar	34	0.247
Bani Naeem	25	0.216
Saer	17	0.611
Shioukh	5	1.060
Tafuh	22	0.386
Yatta	25	0.489
Total	198	4

Estimated contaminated area from stone cutting in the Hebron District. Source: Al-Joulani 2008.

The stone industry is clearly of great economic importance. However, many problems and challenges must be addressed at the national and local levels in order to realize potential gains. The major environmental challenge is the disposal of the stone slurry waste generated during stone cutting and shaping (Al-Joulani 2012)

In early 2012, USAID recognized that Israelis and Palestinians alike had an interest in ending the illegal disposal of slurry, both because of its environmental and health hazards and because of the key role the stone and marble industry plays in the West Bank economy (Kahrmann 2013). In May 2012, the USAID water resources and infrastructure office along with representatives from the stone-cutting industry in Hebron reached an agreement to help stop the slurry's release into the wastewater system. Illegal connections to the sewer system were sealed, and liquid slurry waste from factories is now transported to a central processing plant where it is treated and water is recovered for reuse by the factories and the municipality (Ibid.).

Currently, more than 15,000 m^3/month of solid sludge and liquid slurry waste are transported to the Yatta municipal landfill, where it is used to form a cover over solid waste. The layer of slurry and sludge has benefited the villagers living near the Yatta landfill by capping the smells coming from the hills of trash and reducing the number of disease-carrying flies and mosquitoes. Furthermore, it has been reported that significantly fewer feral animals are found feeding on the household garbage in the landfill (Kahrmann 2013).

USAID is exploring additional long-term solutions to the sludge problem, including obliging stone-cutting companies to purchase individual filter presses, which dry and compact the slurry. Water extracted from the slurry is then reclaimed and reused to cool the blades used to cut the stone.

The compacted slurry has the potential to be turned into useful by-products such as gypsum boards, floor tiles, concrete bricks, ornamental fixtures and even pharmaceutical products (Ibid.).

CONCLUSION

The gathering of water-quality data along the Hebron Stream on both sides of the Green Line is a first step in resolving the transboundary wastewater conflict between Israel and the Palestinian Authority. Our work takes a basin approach to the restoration of the Hebron/Besor watershed and aims to develop a more efficient bilateral approach to the treatment and reuse of wastewater to replace the unilateral approach currently in place. However, given the complex nature and diverse sources of wastewater in the area (particularly the stone slurry waste), this is a challenging task. In order to resolve this particular issue, all stakeholders (policy makers, factory operators, water experts, etc.) need to be engaged in identifying the best possible approach to removing stone slurry waste from the watershed through on-site and at-source stone slurry wastewater treatment. The data we are producing clearly indicates the severe pollution of the Hebron/Besor Stream. By communicating and disseminating this data to all stakeholders, we hope to begin the process of effective cross-border stakeholder dialogue to resolve the issue for the benefit of the local communities and the environment.

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ENDNOTES

1. The term "transboundary waters" refers to sources of freshwater that are shared among multiple user groups, with diverse values and different needs associated with water use. In this way, water crosses boundaries - be they those of economic sectors, legal jurisdictions, or political interests. From sets of individual irrigators and environmental advocates, to urban versus rural uses, to nations that straddle international waterways, essentially, all freshwater is transboundary water, and is important to society at local, national, regional, and international scales. Transboundary waters share certain characteristics that make their management especially complicated, most notable of which is that these basins require a more complete understanding of the political, cultural, and social aspects of water, and that integrated management is dependent on extremely intricate awareness of the decision-making process.
2. The de facto border between Israel and the West Bank.
3. Area C is that region of the West Bank where, according to the Oslo Accords signed between Israel and the Palestinian Liberation Organization (PLO), Israel retains both civil and military control.
4. Administrative divisions of the Occupied Palestinian Territories as outlined in the 1995 Oslo II Accords between Israel and the Palestine Liberation Organization. Area A, according to the Accords, consists of land under full civilian and security control by the Palestinian Authority (PA). Area B is Israeli controlled but PA administered, while Area C is controlled entirely by the Israeli government, with authority over both civil administration and police. Areas B and C constitute the majority of the territory, comprised mostly of rural areas, while urban areas – where the majority of the Palestinian population resides – are mostly in Area A.
5. The Israeli-Palestinian Joint Water Committee (JWC) is a joint Israeli-Palestinian authority, created in 1995 under the Oslo II Accords. Its purpose is to manage water- and sewage-related infrastructure in the West Bank, particularly to take decisions on maintenance of existing infrastructure and approval of new projects. Although it was originally intended to be a temporary organ for a five-year interim period, it still exists as of 2014.
6. The Mountain Aquifer is one of the most significant sources of water for both Israelis and Palestinians. Nearly the entire Palestinian population in the West Bank is dependent on springs, wells or water extracted from the Mountain Aquifer for drinking and other uses. In Israel, the Mountain Aquifer supplies water to major population centers.
7. As part of Israel's continued commitment to improving wastewater recovery and reuse, in 2005 a draft set of wastewater reuse standards was published containing 38 updated water-quality parameters. These are known locally as the Inbar Standards after the inter-ministerial committee chairman, Dr. Yossi Inbar, who oversaw the standard review. The Israel Ministry of Environmental Protection and the Ministry of Health adopted these standards in 2007. This new policy requires all future wastewater treatment plants to be able to produce wastewater at a level that allows for "unlimited irrigation or discharge to streams", while existing wastewater treatment plants must be upgraded to meet the new standards. The purpose of the Inbar regulations is to protect public health, prevent pollution of water resources from sewage effluents and enable the use of wastewater recovery for safe discharge back into streams whilst protecting the environment, including ecosystems and biodiversity, soil and crops.
8. The Beer Sheva River Park is a multi-million dollar project to revitalize the downtown area of Beer Sheva by developing recreational and commercial activities. The Beer Sheva River is a central feature of the park.

6. The Drin Coordinated Action

Towards an Integrated Transboundary Water Resources Management

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KEYWORDS: DRIN RIVER BASIN, TRANSBOUNDARY WATER MANAGEMENT, PARTICIPATORY DIALOGUE

Abstract

The Drin River is a complex transboundary water system and a strategic developmental resource for its riparian states. Though bilateral and sub-basin cooperation have been in place for quite some time, a basin-wide effort towards sustainable management was initiated only in 2008. The riparians, the national and regional stakeholders, and the international development community are engaged in that evolving process. Good practices from the region and beyond provide valid background for building consensus among riparians and stakeholders through participatory processes, and for long-term planning to tackle interdependent development objectives. While continuing to build a knowledge base and advancing the policy instruments, the time is ripe for advancing joint institutional structures and launching implementation in response to agreed principles and priorities. This article describes the ingredients of progress towards today's achievements. It aims not only to tell the developing Drin story, but also to provide lessons learned that could inspire replication elsewhere.

INTRODUCTION

The Drin process directly contributes to regional stability and security and offers an example for the Mediterranean and beyond.

Transboundary water resources are equally important for the economic, social, and environmental well-being of communities in all riparian states. The Mediterranean is, by definition, a transboundary region. Particularly in South Eastern Europe (SEE), 90 percent of the waters fall within transboundary basins and more than 50 percent of these basins are shared by three or more riparians. In addition, there are more than 50 transboundary aquifers and many of them are interlinked with surface water bodies.

Despite their importance, transboundary waters have for centuries been used in a rather *ad hoc* way without proper management planning. The current modes of development, production and consumption, in combination with demographic changes and increasing climate variability and changes, exert additional pressures on water resources and increase their vulnerability as well as the interdependencies among users, frequently threatening the harmonious relationships among sectors as well as among countries. These factors, along with issues related to the sovereignty of states, make cooperative management of transboundary waters challenging.

Notes:
1. This chapter adheres to the UN rules regarding the use of names as well as the international status of countries and/or other areas etc. The use of names, maps or other statements in this chapter in no way reflects any position of the authors in this domain.
2. The views expressed in the article are those of the authors and do not necessarily reflect the views of the United Nations Economic Commission for Europe.

UNECE WATER CONVENTION

This global convention obliges parties to prevent, control, and reduce transboundary impact, use transboundary waters in a reasonable and equitable way, and ensure their sustainable management. Parties bordering the same transboundary waters shall cooperate by entering into specific agreements and establishing joint bodies, preferably on the level of an entire basin.

THE JOINT ATHENS DECLARATION-PETERSBERG II PROCESS

Initiated in 1998, the Petersberg Process focuses on cooperation over the management of transboundary waters. The Petersberg Process – Phase II aims to provide support to translate into action the current developments and opportunities for future cooperation on transboundary rivers, lakes and groundwater management in SEE. It is supported by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, and the World Bank.

The Athens Declaration Process concerning Shared Water, Shared Future and Shared Knowledge was initiated in 2003. It provides a framework for a long-term process to support cooperative activities for the integrated management of shared water resources in the SEE and Mediterranean regions. It is jointly supported by the Hellenic Ministry of Foreign Affairs and the World Bank.

The two processes progressively came together in order to generate synergies and maximize the outcomes for the benefit of the SEE region. Activities within the process are primarily supported by the governments of Germany and Greece and the World Bank. Global Water Partnership-Mediterranean provides technical and administrative support.

For more information, see: www.twrm-med.net/southeastern-europe/southeastern-europe/regional-dialogue/framework/petersberg-phase-ii-athens-declaration-process.

The Global Water Partnership (GWP) is one of the international organizations advocating that "surface and underground water do not respect political boundaries. This means that states must cooperate to manage water" (GWP Strategy 2009-2013). International law is one of the tools for facilitating such cooperation (Wouters 2013). However, in many cases, initiation of cooperation and negotiation of international legal instruments that will detail the means and modes of cooperation is a very difficult and complex process.

Given the difficulties and challenges, the identification or creation of a "window of opportunity" for generating the enabling environment for cooperative arrangements is crucial. A combination of bottom-up, top-down, and traditional *ad hoc* arrangements can be used in this regard. This combined approach has been applied in the case of the Drin River.

Strengthened transboundary cooperation in the Drin Basin is one of the key outcomes of the 'Regional Dialogue on Transboundary Water Resources Management in South Eastern Europe', that has been carried out since 2005 to promote sustainable management of transboundary basins and shared water bodies. The Regional Dialogue aims to catalyze action in the field of transboundary water resources management (TWRM) by debating and showcasing the benefits of cooperation. The activities under the Regional Dialogue (assessments, international roundtables, capacity building workshops, study tours, etc.) have been used to enable stakeholders to identify solutions that can be applied in their respective basins. The participation of the Drin stakeholders in these events was a catalyst for the initiation of the Drin Dialogue at the end of 2008. Both dialogues were initiated under the Petersberg Phase II / Athens Declaration Process and were implemented in synergy with the GEF IWLEARN Programme.[1] The UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention),[2] with three of the riparians as parties (Albania, Greece, and recently Montenegro), provides the broadly accepted interpretation of international water law in the region.

The EU Water Framework Directive[3] further provides an important political framework, while the Mediterranean Component of the EU Water Initiative[4] (MED EUWI) offers a policy framework for developing activities.

THE DRIN RIVER BASIN

The Drin Basin extends through a large part of the Western Balkans. It consists of several sub-basins, the uppermost of which is that of the Prespa Lakes, while the lowest is that of the Buna/Bojana River, adjacent to the Adriatic Sea. The Drin River is the "connecting agent" of the Drin Basin, linking tributary rivers, lakes, aquifers, and other aquatic habitats into a complex, single ecosystem of major importance.

THE DRIN BASIN

- Total surface area: 19,582 km2
- Shared between Albania, the Former Yugoslav Republic of Macedonia, Greece, Kosovo and Montenegro
- Transboundary water bodies: Drin and Buna/Bojana Rivers, Lakes Prespa, Ohrid and Skadar/Shkoder
- Areas in Lake Prespa, Lake Skadar/Shkoder and Buna/Bojana River sub-basins are protected under the Ramsar Convention as Wetlands of International Importance
- The lakes and Buna/Bojana Delta have a high rate of endemism
- Hydropower plants installed in the Albanian Drin produce 85 percent of hydropower in Albania and represent 70 percent of the total hydro- and thermal-installed capacity in the country
- Overall, there are 44 dams in Albania (four for energy production and 40 for irrigation purposes) with a capacity that varies from 0.07 million cubic meters up to 2.7 million cubic meters. Two additional large dams on the Black Drin in the Former Yugoslav Republic of Macedonia were built with hydroelectric power generation as their main purpose.

The Prespa Lakes sub-basin comprises two lakes; the Micro Prespa, shared by Greece and Albania, and the Macro Prespa, shared by Albania, Greece and the Former Yugoslav Republic of Macedonia. Water flows through underground karst channels from the Prespa sub-basin to Lake Ohrid. Shared by Albania and the Former Yugoslav Republic of Macedonia, Lake Ohrid is the largest lake in terms of water volume in SEE. The only surface outflow of Lake Ohrid, the Black Drin, flows north through the Former Yugoslav Republic of Macedonia and enters Albania. Here it meets the White Drin, which originates in Kosovo, to form the Drin River. Flowing westward through Albania, the Drin joins the Buna/Bojana River 1 km downstream of the outlet of Lake Skadar/Shkoder, near the city of Shkodra. Shared by Albania and Montenegro, Lake Skadar/Shkoder is the largest lake in terms of surface area in SEE. The Buna/Bojana River drains Lake Skadar/Shkoder sub-basin and flows into the Adriatic Sea; its final tract (23 km) forms the Albania-Montenegro border (Fig. 1).

FIGURE 1

The "extended" Drin Basin. Prepared by the World Bank Group, October 2006.

The Drin transboundary system offers an excellent example of interdependencies between different human uses (agriculture, hydropower generation, industry, fisheries, tourism, urban settlements, etc.) as well as among uses and ecosystems, in four major interconnected inland water bodies and a receiving sea.

Until recently, management was practiced mainly at a national level and was not sustainable. Limitations in institutional settings, governance provisions and capacities as well as a lack of financial resources for infrastructure and management were the main reasons for this failure.

Despite these difficulties, legally binding agreements on water resources and ecosystem management cooperation were established between riparians to each of the three international lakes in the Drin system. However, a framework for coordinated action at the Drin Basin level remained absent.

In November 2008, key national stakeholders and international partners initiated a discussion to develop cooperation between the Drin Basin riparians. Guided by the riparians, a structured multi-stakeholder process unfolded, facilitated by international organizations and supported by donor countries and multilateral agencies. The result was the creation of trust, the establishment of a community of practice and the development of a shared vision for the Drin Basin. Going forward, the challenge for riparians – with the engagement of national stakeholders and the assistance of the international community – is to translate the agreed shared vision into action and establish an official framework for cooperation for the sustainable use of water resources.

DRIN BASIN – BASELINE SITUATION

Parts of the Drin Basin are quite developed whereas others are virtually undisturbed. Agriculture is the main economic sector here. Timber exploitation is locally important. Fishing is a significant source of income for population groups around the three lakes. Gravel extraction is one of the environmentally detrimental activities in the area though it is not extensively practiced. Copper and chromium ore are still extracted in the Albanian part of the Drin basin. Several other forms of heavy industry exist in parts of the watersheds of Lakes Prespa, Ohrid and Skadar/Shkoder. The Drin River is important for energy/hydroelectricity production. There are plans for the construction of some additional dams in the riparian countries. The importance of tourism varies across the basin. It is significant around Lake Ohrid and there are plans for tourism development in other parts of the Drin Basin. With the exception of Greece, the riparians that are transitioning from centralized to market economies have comparable levels of economic development. The reform process is driven mainly by the prospect of EU accession (Faloutsos et al. 2014).

DEVELOPING A SHARED VISION – ESTABLISHING COOPERATION

The Drin Dialogue

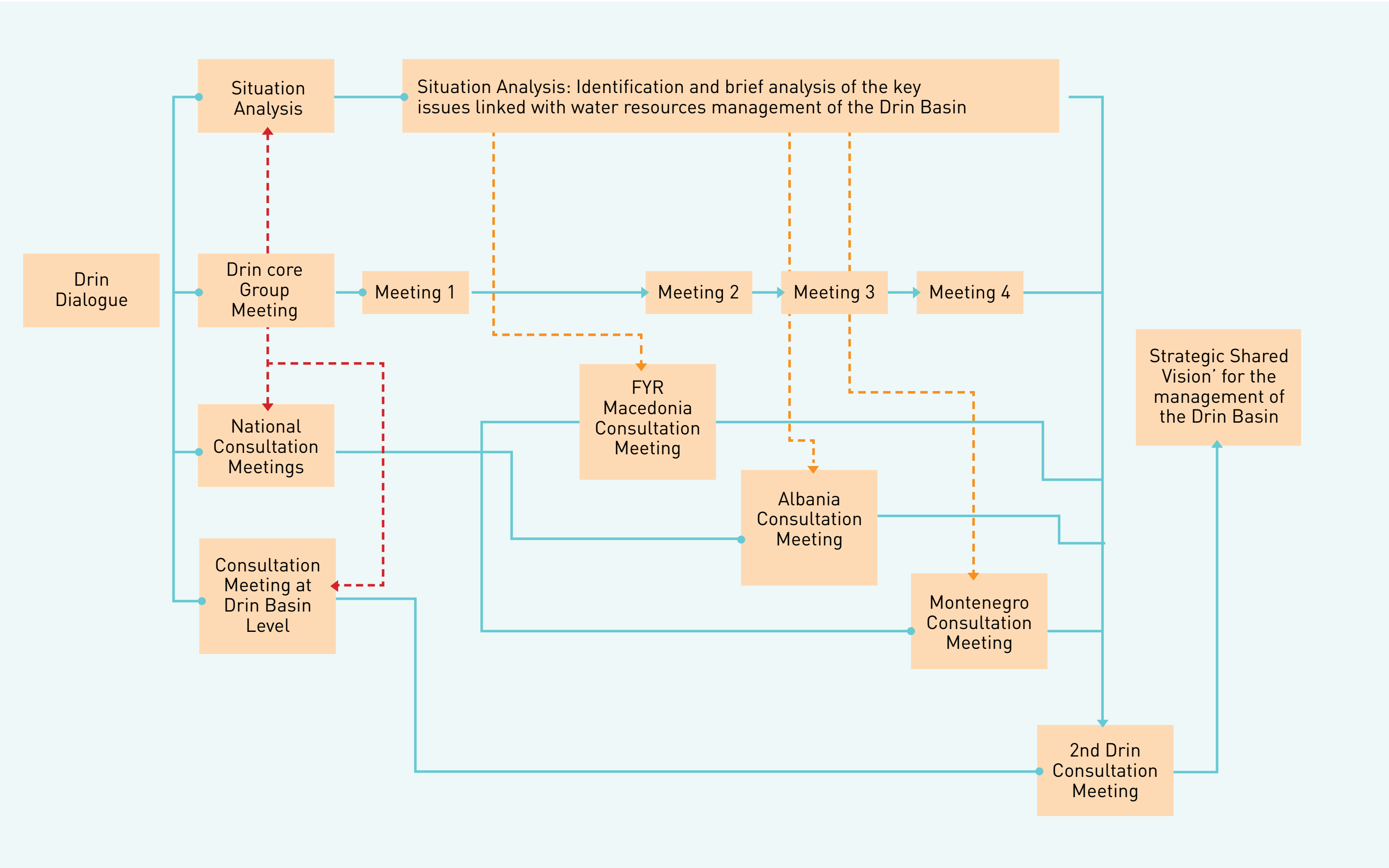
Following initial steps taken in 2008, a multi-stakeholder process for the establishment of a shared vision for the sustainable management of the Drin Basin, the Drin Dialogue, was formally launched on 1 December 2009, in Podgorica, Montenegro. The dialogue was led by the competent ministries of Albania, the Former Yugoslav Republic of Macedonia, Greece, Kosovo, and Montenegro. The Drin Dialogue was completed after two years, on 30 November 2011, when the five Drin River riparians signed a 'Memorandum of Understanding for the Management of the Extended Transboundary Drin River Basin'. It was a structured, sophisticated, step-by-step process, facilitated by UNECE and GWP-Med. It comprised targeted assessment and a number of consultation meetings at national and transboundary levels. Competent ministries, national agencies, users, academics, the private sector, international institutions and donor countries worked together to ensure all parties acquired the necessary ownership of the required actions to enhance cooperation and solutions for the sustainable management of the basin.

A situation analysis was prepared to inform the discussions. This enabled the identification of the main transboundary issues and their causes, as well as some of the drivers of the policies and the management instruments. The riparians validated the outcomes of the situation analysis, which were then presented to the stakeholders for discussion and feedback.

The process was guided by a Steering Committee (SC) that comprised representatives from all Drin riparians, mostly meeting back-to-back with the dialogue's consultation meetings. This facilitated the establishment of the necessary political constituency. The dialogue was ultimately governed at the political level; the political leadership of the ministries appointed the SC members and participated in the consultation meetings. Importantly, the dialogue outcomes were not pre-defined; the riparians were free to negotiate or even withdraw from the dialogue.

As an intermediate outcome, a 'Ministerial Declaration on the Management of the Extended Drin Basin' was agreed in Ohrid, Former Yugoslav Republic of Macedonia, on 18 April 2011, providing further political impetus to the process. This enabled the elaboration of a shared vision with high political backing, which was included in the signed Memorandum of Understanding (Fig. 2).

FIGURE 2



Schematic representation of the Drin Dialogue Process.

The Drin Memorandum of Understanding

The key political outcome of the Drin Dialogue was the signing of the 'Memorandum of Understanding for the Management of the Extended Transboundary Drin Basin' (Drin MoU 2011) by the ministers responsible for the management of water and the environment in the respective riparians.

The riparians chose to develop the Drin MoU for signing by the main water agencies instead of initiating negotiations on an intergovernmental agreement. Indeed, negotiations and the ratification of intergovernmental agreements can take many years, but this approach made it possible to productively use the window of opportunity provided by a strong political willingness to develop cooperation. As is reflected below, the Drin MoU also included elements such as the institutional structure for cooperation usually found in agreements, which so far has made its application action oriented.

The main objective of the Drin MoU was the attainment of the shared vision. The Drin riparians committed to "promote joint action for the coordinated integrated management of the shared water resources in the Drin Basin, as a means to safeguard and restore, to the extent possible, the ecosystems and the services they provide, and to promote sustainable development across the Drin Basin."

The Drin MoU identifies short-, medium- and long-term actions to address problems identified as affecting sustainable development in the entire Drin Basin and in one or more of its sub-basins. The preparation of an Integrated Drin Basin Management Plan is the long-term objective. To achieve that, a process called the Drin Coordinated Action was put in place, succeeding the Drin Dialogue.

MOU FOR THE MANAGEMENT OF THE EXTENDED TRANSBOUNDARY DRIN BASIN - COMMON CONCERNS FOR SUSTAINABLE DEVELOPMENT OF THE DRIN BASIN (EXTRACTS)

The signatory parties identify in this agreement concrete problems affecting sustainable development and agree to take action to address these.

"The Parties hereby should undertake concrete actions to address problems identified as affecting sustainable development in the entire Drin Basin or in one or more of the Sub-Basins:

(i) Improving access to comprehensive data and adequate information to fully understand the current state of the environment and the water resources and the hydrologic system (including surface, underground and coastal waters) as well as ecosystems of the Drin Basin;

(ii) Establish conditions for a sustainable use of water and other natural resources;

(iii) Develop cooperation and measures to minimize flooding especially in the lower parts of the Drin Basin;

(iv) Improve management and appropriate disposal of solid wastes;

(v) Decrease nutrient pollution deriving from untreated or poorly treated wastewater discharges and unsustainable agricultural practices;

(vi) Decrease pollution from hazardous substances such as heavy metals and pesticides;

(vii) Minimize effects of hydro-morphologic interventions that alter the nature of the hydrologic system and the supported ecosystems, resulting in their deterioration."

Source: http://drincorda.org/the-memorandum-of-understanding-for-the-management-of-the-drin-basin/MoU_DrinStrategicSharedvision_Final.pdf

The Drin Coordinated Action

While the process is ongoing, a number of activities have already been implemented under the Drin Coordinated Action, responding to the Drin MoU that defines the steps and the conditions for its implementation.

An institutional structure based on the Drin MoU was established in 2012 (Fig 3). It includes:

- The **Meeting of the Parties**: according to Article 6 of the MoU "the Ministers responsible for the management of water resources and/or environment of the five Parties shall meet annually to review progress in the implementation of the present MoU and its provisions." The first Meeting of the Parties (MoP) was held on 28 May 2013 in Tirana, Albania.

- The **Drin Core Group** (DCG). This body is given the mandate to coordinate actions for the implementation of the MoU. The DCG comprises representatives of the (i) competent ministries of the riparians, (ii) the (pre)existing joint structures,[5] (iii) UNECE, (iv) GWP-Med, and (v) the Mediterranean Information Office for Environment, Culture and Sustainable Development (MIO-ECSDE) representing civil society. According to the MoU, "the decisions of the DCG will be taken by the representatives of the Parties (i.e. the Drin Riparians) on the basis of consensus." There are two ordinary DCG meetings per year.

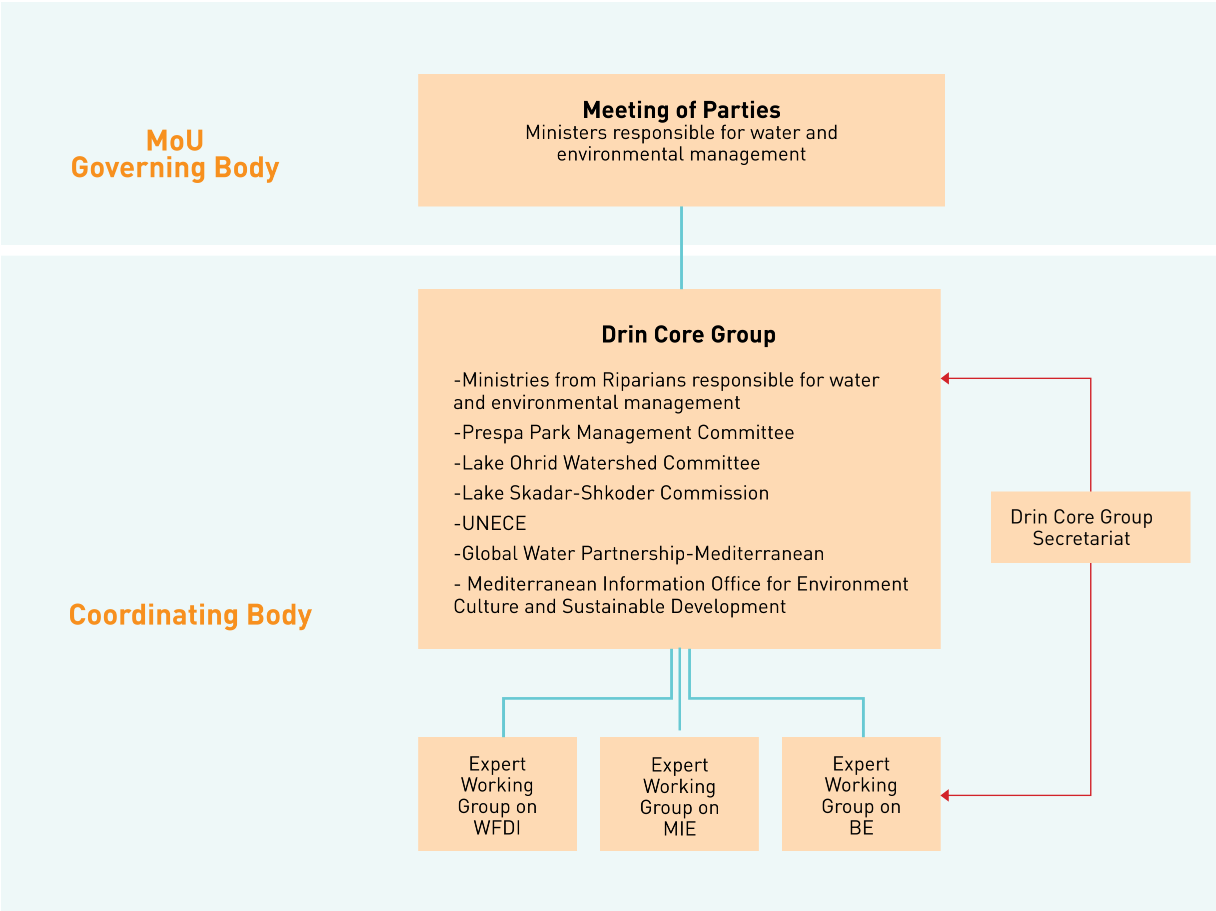
The DCG Secretariat provides technical and administrative support to the DCG; GWP-Med serves by appointment of the Parties through the MoU as the Secretariat.

Three **Expert Working Groups** (EWG) were established in 2012 to assist the DCG in its work:

- Water Framework Directive implementation EWG.
- Monitoring and Information exchange EWG.
- Biodiversity and Ecosystem EWG

Their operation has been delayed due to a lack of adequate financing.

FIGURE 3



Drin MoU bodies: institutional structure for the implementation of the Drin MoU (www.drincorda.org)

The Drin Action Plan

The primary aim of the ongoing work in the Drin Basin is to move from the sharing of waters between states and conflicting uses to a proper application of international water law and the sharing of benefits between riparians and stakeholders, in a basin where all its parts are physically, culturally and historically interconnected.

The Drin Action Plan[6] (DAP) was prepared to facilitate implementation of the Drin MoU and operationalize the Drin Coordinated Action. This is considered an 'evolving document' and has been subject to updates and amendments in accordance with the decisions of the Meeting of the Parties to the Drin MoU and the DCG. The DCG and its Secretariat guides the implementation of the DAP. The DAP is already being implemented using resources made available by various donors active in the basin.

Future Action

Resources for the full implementation of the DAP activities have been secured through the Global Environment Facility[7] (GEF) which supports the project "Enabling Transboundary Cooperation and Integrated Water Resources Management in the Extended Drin River Basin" (GEF Drin project).[8]

The GEF Drin project is aligned in content, aims, objectives and governance structure with the activities of the Drin Coordinated Action. The objective of the project is to promote joint management of the shared water resources of the transboundary Drin River Basin, including coordination mechanisms among the various sub-basin joint commissions and committees. It will assist in the operationalization of the institutional structure, rendering it capable of undertaking its coordinative and executive role. It will also further enhance scientific knowledge of the basin to assist the riparians to make informed decisions for selecting priority transboundary issues to be addressed through related management options. A set of agreed measures will be developed to form a Strategic Action Plan. The systematic involvement of stakeholders, including civil society, will be continued and enhanced. The United Nations Development Programme (UNDP) is the implementing agency and GWP, GWP-Med and UNECE are the executive partners of the GEF Drin project.

Greece is not eligible for financing, nor was Kosovo at the time of the project preparation. Greece will use its own resources for financing activities in its part of the Drin Basin. With regards to Kosovo, the participation of representatives in the institutional structure of the Drin Coordinated Action has been secured; in addition, the DCG Secretariat (GWP-Med) and UNECE are actively exploring funding possibilities for extending activities to the White Drin Basin.

CONCLUSIONS: LESSONS LEARNED

The documented enhancement of cooperation in the Drin Basin demonstrates the success of the approach practiced, i.e. working both top-down, using high-level meetings, and bottom-up, through stakeholder consultations at national and regional levels. Though the process is ongoing, there are lessons that can be shared after six years of structured efforts:

- *The common realization that nobody wins from the business-as-usual scenario is the basis for initiating cooperation:* There was wide recognition of the existing challenges and the need for solutions related to Drin River Basin management. The enabling environment for action was catalyzed and sustained by independent international institutions, which hold convening power and functioned as 'trust brokers'. UNECE, GWP-Med, GEF, UNDP, Sweden, Germany, and more partners were engaged early on and had a discrete but steady supporting role.

- *High-level political will and practical engagement of the administration is a must:* The governments of the Drin riparians, represented at high level, were the key political drivers of the process from the time it was launched. At the same time, involving the competent ministries in all activities (assessments, consultations, capacity building, etc.) was of key importance for enhancing understanding, ownership and the ability to act within the public administration.

- *An honest and step-by-step consensus-building process among riparians is necessary:* As the process had no predefined outcomes, the Drin riparians understood that there was no hidden agenda or threat to their interests. A primary aim of the Drin Dialogue was to establish a culture of cooperation and initial institutional mechanisms; the riparians could also use these to further negotiate solutions with regard to conflicting interests.

- *Multi-stakeholder consultation processes are essential tools for enhancing ownership and facilitating decision-making:* Stakeholders had a strong interest in contributing and the Drin Dialogue provided the opportunity to national institutions, joint commissions, local authorities, users, academics, civil society and the private sector at local, national and regional levels to express their views. Their vivid and consistent participation in the work and consultations demonstrated a shared and genuine wish to move forward.

- *A solid knowledge base and a shared prioritization of issues are necessary to advance consultation and decision-making:* The situation analysis provided the science-informed background to generate discussions within the Drin Dialogue and enabled consensus on the key issues and the direction of managerial activities.

- *Reinventing the wheel wastes effort, money and time:* To avoid duplication of efforts and save on resources, the existing structures, institutions and processes such as the joint commissions/committees of the international lakes, were fully embraced and engaged from the beginning of the process.

- *Seed funding can be enough to initiate a process and make progress:* over six years, the process was funded by very limited resources from the governments of Sweden and Germany, GWP-Med and UNECE. This shows that where there is a will there is a way. Of course, substantially more resources would be needed to apply what has been agreed on and further develop cooperation; steps towards securing these funds, including from the riparians, are coordinated.

These approaches have been efficient in the establishment of a shared vision for the management of the basin and the signing of a Memorandum of Understanding by the competent ministers of the riparians. The content of the cooperation agenda was decided on and reflected in the Drin MoU. The MoU provided for political leadership by direct involvement of ministers through the annual Meeting of Parties and the establishment of a coordination body, the Drin Core Group, supported by a day-by-day Secretariat, and assisted technically by three Expert Working Groups.

The competent authorities will translate the cooperation agenda into actions on the basis of the actual needs, priorities and opportunities for cooperation and economic development. The riparians will further be provided – through the GEF Drin project – with tools that will enable them to negotiate and reach informed decisions with regards to the level and type of cooperation regarding issues as: exchange of information and data; flood management; creation of an appropriate institutional structure based on what is already established through the Drin Coordinated Action etc.

The ultimate goal of the ongoing work in the Drin Basin is to reach a point in the medium term where the scale of management is elevated from water bodies to the interconnected hydrological system of the Drin Basin. The primary aim is to move from the sharing of waters between states and conflicting uses to a proper application of international water law and the sharing of benefits between riparians and stakeholders, in a basin where all its parts are physically, culturally, and historically interconnected.

In this regard, the ongoing Drin Coordinated Action provides a solid vehicle for the development of further political consensus and practical cooperation among the riparians. This is particularly important in an area that has, in the not so distant past, witnessed armed conflicts, and where a number of groups of different identity, origin and religion reside, but that encompasses a number of riparians that work hard towards political and economic stability. In this sense, the Drin process directly contributes to regional stability and security, something that is recognized by the riparians and the international community, and offers an example for the Mediterranean and beyond.

ACKNOWLEDGEMENTS

Thanks to Vangelis Constantianos, GWP-Med Executive Secretary, for his close reading and suggestions.

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1. http://iwlearn.net/
2. www.unece.org/env/water/
3. http://ec.europa.eu/environment/water/water-framework/index_en.html
4. http://medeuwi.ypeka.gr/
5. Prespa Park Coordination Committee; Lake Ohrid Watershed Committee; Skadar/Shkoder Lake Management Commission.
6. Approved by the 6th DCG meeting (Ohrid, 30 May 2012) and endorsed by the 1st Meeting of the Parties (Ministerial meeting in Tirana, 28 May 2013). The project is structured around six actions:
    - Enhancement of coordination mechanisms among the parties.
    - Enhancement of the knowledge basis about the Drin Basin.
    - Improvement of information exchange through the establishment of a system for regular exchange of relevant information among the competent authorities of each party.
    - Enhancement of cooperation in the field of flood risk preparedness, management and mutual support.
    - Institutional strengthening in the field of integrated water resources management.
    - Promotion of public participation and stakeholders engagement.

    More information as well as the Action Plan can be found at http://www.twrm-med.net/southeastern-europe/supported-processes-and-projects/drin-river-basin/the-action-plan-for-the-implementation-of-the-drin-mou
7. www.thegef.org/
8. The project proposal was approved by the GEF Council (Washington, 13-15 November 2012) and endorsed by the Drin Core Group. The GEF Drin project ($4.5 million) is structured around five components:
    - Component 1: Consolidating a common knowledge base
    - Component 2: Building the foundation for multi-country cooperation
    - Component 3: Institutional strengthening for Integrated River Basin Management (IRBM)
    - Component 4: Demonstration of technologies and practices for IWRM and ecosystem management
    - Component 5: Stakeholder Involvement, Gender Mainstreaming and Communication Strategies

7. The Times They Are A-Changin': Water Activism and Changing Public Policy

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FIGURE 1

The Clearwater at sail on the Hudson River. Photo: Henry C, 2007.

KEYWORDS: WATER MANAGEMENT, SOCIAL MOVEMENTS, PUBLIC POLICY

Abstract

Despite widespread and justifiable pessimism about freshwater management in the world's arid regions, including the Middle East and the Mediterranean, there are signs that, at least in some countries, social movements organized by individual activists are having an effect on public policy. Whether led by artists and celebrities, farmers, villagers concerned for their health, or young activists disgusted with government inaction, social movements for environmental change are having some success even in countries like Greece where mismanagement of water resources has been egregious. No single solution fits the widely differing situations of the region, but local action, particularly when supported by a framework of international law, can sometimes effect change.

In the countries of Middle East and North Africa, the shortage of fresh water, especially water clean enough to drink, has already reached crisis proportions. In the Euro-Mediterranean, the situation is less critical, but if climate predictions can be believed, water scarcity will soon be a serious problem in those countries. Pollution of rivers, destruction of wetlands, and the drying up of groundwater are common throughout the area, and it is hard to envision a scenario where water problems will not increase. Changing the situation requires not only technical innovation but also economic development and political will. Perhaps more than both of these, it requires public education and the realization, among users of water, that they must change their current behavior.

CHANGE AND SOCIAL MOVEMENTS

When change does not happen voluntarily it can be achieved in many different ways and by a varied cast of players. Unlikely alliances can be formed, and non-stakeholders can play key roles. Internationally, remarkable results have been achieved by individuals and groups, not only through the more established environmental movements, but also by artists, villagers, farmers and journalists. This is true of the Mediterranean countries of E.U., where environmental activism is achieving victories in Spain, Italy, and Greece, but sadly less so in the Middle East and North Africa, where activists continue to be arrested and imprisoned. Nevertheless the case of Greece (see below), which until the end of the twentieth century had a dismal record of environmental action and a corrupt central government unwilling to protect natural resources, may offer some encouragement to neighboring countries.

In some cases there has been an appeal to imagination or tradition, in others, to practical necessities or community fears. In the pages that follow I tell the stories of four river basins, and how environmental change has been effected in each case by diverse actors and means. The stories suggest that there is no one solution to problems of water. Dwindling or polluted water triggers individual and community concern, but from there to successful policy change is an unpredictable path, one each community has to follow using whatever resources it can.

Before I begin my river tales, a word about social movements and a brief nod to the theorists who have studied them. Charles Tilly (1994) defined social movements as constituting not so much a group but an interactive cluster. Generally, three populations are involved: power-holders, activists, and a subject population on whose behalf activists are making or supporting claims (1994: 15). There have been modifications to the theory, and arguments about the nature of the movements' composition and identity, but it is recognized that all such movements involve combinations of social networking, a generally informal organizational structure, and an ability to mobilize resources. Sidney Tarrow (1998) observed that even when local movements are weak or non-existent, international currents of opinion, such as environmentalism, can generate a belief that changes are inevitable. In the absence of a local or national social movement, environmentalism may still lead to the creation of environmental ministries and organizations (1998: 162). What distinguishes the environmental movements in countries such as Italy and Spain is that they cross ideological and political boundaries. As Tilly and Tarrow both observe, there is no single model of movement organization.

FOUR RIVER TALES

The Hudson River, New York, U.S.A.: a man, a song, and a sloop

The earliest attempt to save a river by cultural environmental activism was probably the Clearwater project on the Hudson River. Officially called the Hudson River Sloop Clearwater, Inc., it was begun in 1966 by folksinger and activist Pete Seeger at a time when the Hudson River was, like many other American rivers, filthy with oil and chemical pollution estimated at 170 times the safety limit. Enlisting the support of fellow artists and activists, Seeger decided to build a sloop in the style of the sailing ships that carried goods and passengers along the Hudson in the eighteenth and nineteenth centuries. The thirty-two-meter-long replica was launched in 1969. At the same time a music festival, the Clearwater Festival, was inaugurated to help promote the mission of cleaning up the river and inspiring thousands of young people to become involved in the environmental movement. The Clearwater's original approach to environmental change and the restoration of a once-pristine river was extraordinarily successful; at least in part as a response to Seeger's organization, the Hudson was dredged and restored almost to its original condition.

In 1972 Seeger and his crew sailed the Clearwater to Washington, D.C. while Congress was debating the Clean Water Act. He delivered a petition with hundreds of thousands of signatures to Congress and then held a spontaneous concert in the Congress. The Federal Water Pollution Control Act was passed a few weeks later despite President Richard Nixon's veto. Seeger's voice was one of many. Environmental activists, concerned citizens, government agencies, biologists and other scientists had all urged the federal government to pass legislation that would protect waterways, clean up polluted rivers and preserve wetlands. A creative gesture of environmental activism by a famous artist not only helped push through the most significant piece of water legislation in U.S. history, but Seeger and his group of activists continued educating young people about the need to preserve the state's waterways for another forty-five years. The Clearwater still sails the Hudson as a floating classroom, teaching elementary schoolchildren about the river (Fig. 1).

The Murray-Darling River Basin, Australia: demon farmers?

Unlike the Hudson, but like many rivers in the Mediterranean and Middle East, the Murray-Darling, the largest river system in Australia, flows through arid country, is vulnerable to drought, and has been the subject of conflicting demands for its diminishing flow. The question of governance of the Murray-Darling Basin (MDB), has engaged state and federal governments, farmers, and activists for decades in acrimonious debates about the allocation of water. The water is largely used to irrigate pasture, although irrigated crops are also grown in areas close to the rivers. A combination of a decade-long drought and overuse of the water for irrigation caused the rivers to dry up in many places, and the mouth of the system to close at the turn of the twenty-first century. In 2010, the Murray-Darling Basin Authority (MDBA), which had been established to try to restore the health of the basin, produced a plan. The plan was designed to limit the quantity of water that could be taken from the basin for irrigation purposes, and set standards for water quality and salinity. There was also a scheme for water trading across the basin, and a requirement for state water resource plans. An overall goal was to minimize the social and economic impact of the changes while achieving the plan's environmental improvements.

When the basin plan was released it sparked intense reaction, especially from farmers and wine growers in the region, but also in the parliament. The rhetoric of the debate became increasingly dramatic. On one side, environmentalists referred to the river system as a living creature whose very existence hung in the balance. Reporting for the *Australian Broadcasting Commission* in September 2011, Chris Daley noted: "Much of Australia's agriculture and environment rely on the Murray-Darling river system. Yet the paltry 2,400 billion litres proposed to save it will only condemn it to a long, slow death" (Daley 2011). In Daley's opinion the MDBA was not buying back enough water to save the river: "This is a cowardly response from an organisation charged with saving Australia's lifeblood. It is an approach with no scientific merit and represents an appalling waste of taxpayers' money. It shows a breathtaking lack of vision and is a compromise that won't placate the book-burners or save the river" (Ibid.).

Like many environmentally concerned Australians who live a long way from the area, Daley cast "wealthy farmers" as the villains for overexploiting the river to support their "geographically ill-suited industry." A group of farmers did, in fact, gather at a town meeting in Griffith where they publicly burned a copy of the plan and threatened legal action should the authority proceed with its plan to return 3,000 to 4,000 billion liters of water to the river system in order to protect the environmental assets and ecosystems (Fig. 2).

A more thoughtful view of the debate was written by novelist and essayist Kate Jennings, whose parents and grandparents settled in the Riverina area and made a scant living from farming. Deploring the inflated rhetoric of the environmentalists, the threat posed by the plan to farming communities, and the environmentalists' ignorance of local conditions, Jennings wrote:

> Surely, with climate change destined to bring about food shortages, we would upgrade our irrigation systems, not destroy them. Worldwide resource depletion means rising energy prices; irrigation areas are critical to our national security. Agriculture can't be concentrated in any one state; the risk needs to be widely spread. Next thought: What country in its right mind would sacrifice a vibrant country town such as Griffith? Ease of transport and economies of scale in farming are causing many towns to gasp and wheeze, but not Griffith.[1] Third thought: How did all of Australia manage overnight to become experts on rice- and cotton-growing? (Jennings 2011).

Jennings interviewed farmers, scientists, and a cousin who was both a farmer and a lawyer. She discovered that farming communities, who had been active in consultation programs in the earlier MDB Commission, had been kept out of any involvement with the formation of the new MDBA in 2008. She also quoted a government report on the impact of the MDB Plan, which notes the variety and complexity of the basin geography, and the plan's failure to take it into consideration.

> The Murray-Darling Basin... comprises 23 river valleys with climactic conditions ranging from rainforest regions, to mallee country, inland sub-tropical to arid and semi- arid land of the far west. The north is characterised by

FIGURE 2

Environmental activists protesting in Adelaide against the degradation of water quality in the Murray-Darling Basin. Photo: Tammy-Jo Sutton, 2012.

semi-arid and ephemeral river systems while the south is known for highly-regulated river systems fed from the Australian Alps (Windsor 2011).

The difficulty of designing a one-size-fits-all plan for an area so vast and varied, especially considering the unreliability of the Australian climate, is, as the government report stresses, as unwise as it is for any such river basin. On the other hand, to treat the rivers and tributaries of the basin as a series of separate rivers makes environmental management impossible.

In the case of the Murray-Darling Basin, environmentalists may have gone too far, but without their efforts, would farmers have adjusted their water demands fast enough? And were the artists, composers, writers, film-makers, and Aboriginal activists wrong to try to raise public awareness of the fragile nature of the MDB through the "One River Project", begun a century ago?[2] Vaguer in intent and less obviously influential, the artistic endeavors intended to draw attention to the MDB's problems have been aligned with the environmentalist agenda of restoring the river basin to an earlier, healthier version of itself. Artists can be, and often are, as naïve and uninformed as any other group of activists, but the thoughtful activist/artist, like Jennings herself, can do much to reverse the damage. Her article is an artfully written and well-informed contribution to a debate that had descended into absurd rhetorical posturing. In the Australian case, states and cities are competing for their share of the river's transboundary water, but it is at least within a single nation. In the case of rivers that transcend national borders, such as the Jordan, the Tigris and the Euphrates, debates become more dangerous, the stakes higher.

The Asopos, Greece: a river revisited

Despite the consolidation of democracy in Greece in the 1980s and 1990s following the 1969-74 military dictatorship, political infighting, and corruption allowed pollution to increase to unprecedented levels. In Athens, air pollution, in the form of a brown cloud hanging over the city (referred to simply as the *nefos*, Ancient Greek for cloud) began to affect the health of its citizens and the marbles of the Acropolis, causing national and international alarm. National and foreign media put pressure on the government to reduce circulation of traffic and the type of heating used in apartment buildings, and since most members of the government lived in the city, it was in their interests to take action. The pollution of Greek rivers and destruction of the rural environment was less obvious.

The Asopos River, which rises on Mt. Cithaeron, and flows into the Gulf of Evia (Euboea) was one of the most polluted rivers in Europe; it even made the website of Erin Brockovich, the environmental activist who became famous for bringing a successful case against Pacific Gas and Electric for polluting groundwater with hexavalent chromium in the town of Hinkley, California.[3] In 2010, after visiting the town of Oinofyta on the banks of the Asopos and seeing its blood-red water, I wrote about the chemical pollution of the river, including the presence of hexavalent chromium, a known carcinogen (Holst-Warhaft 2010: 22-23). I mentioned how concerned the mayor, the local priest, and many townspeople were about the danger of drinking water from the river, and its relation to the high incidence of cancer in the region (Fig. 3).

The Greek government knew all about the pollution. After complaints by residents, a chemical survey was ordered, but despite the results, which indicated a significant health risk not only to residents of the nearby town who depended on the water for drinking, but to a much broader population through the cultivation of crops – especially root vegetables irrigated with water from the Asopos and sold in the vegetable markets of Athens – nothing was done to change the situation. In June 2013, the European Committee of Social Rights upheld a joint complaint submitted in 2011 against the Greek state by the International Federation for Human Rights and the Hellenic League for Human Rights (Enetenglish 2013). The Council of Europe noted that the Greek state knew of the danger to the surrounding population but failed to warn residents about it, a decision that might open the way for those already affected by the pollution to seek compensation. In the present economic crisis, the likelihood of the state actually paying up seems slight. From time to time the state had imposed fines for industrial pollution on some of the companies involved but failed to collect a single euro.[4] On the other hand, this condemnation from one of the highest authorities in Europe drew attention to the persistent problem of corruption and the utter failure of the Greek state to protect one of its most precious resources. It was also an important victory for a lobby that began with years of local activism prompted by concerns about the health risks associated with the water of the Asopos.

In many ways the activism that began in Oinofyta and other affected communities of the Asopos River basin met the criteria for social movements. In Greece, as in other parts of southern Europe, the environmental movement was slow to mobilize because of political issues. Under the 1967-74 military dictatorship, political loyalty was rewarded by large concessions to developers and agriculturalists. In 1969, by presidential decree, in order to give incentives to industries in Boeotia, the Asopos, which divides Attica from Boeotia, was declared an official dumping place for "treated" wastewater from the new factories to be constructed. No plan was put in place for monitoring systems to test the composition or quality of the water released back into the river.

The treaty has remained in place since 1969, with hundreds of permissions granted to new facilities dumping their waste in the river. The Hellenic Space Industry is one of the major polluters of the

FIGURE 3

The Asopos River near Oinofyta, Greece. Photo: Tammo Steenhuis, 2010.

FIGURE 4

Members of the Asopos River movement outside the European Parliament. Photo: EnvironmentFood, 2009.

Asopos, and the government has been unwilling to impose fines on companies polluting the river.[5]

Because of a perceived increase in the incidence of cancer in their town, the population of Oinofyta began to talk to local and state officials from the late 1990s onwards. A survey carried out by the state laboratory of Greece had found high concentrations of chromium in the town's water supply, and a second survey, taken in 2007, found, in addition to chromium, high levels of lead, nitrates and chlorine ions. Ninety-five percent of the total chromium was hexavalent (Passali 2009: 28). There had been small local protests, and a number of reports in the media before 2007, but following the release of the report, mobilization grew, and the question of the contamination of food irrigated with river water and sold in the markets of Athens transformed the issue into a national one. At this stage farmers were in conflict with local activists, since their livelihood depended on irrigation and there was no other source of water available. The participants in the fledgling campaign were mostly educated and skeptical of the government. They formed independent organizations in various communities, including the coastal town of Oropos, and tried to educate local farmers about the health risks involved. Through public meetings, newspaper articles, demonstrations, concerts, and educational activities, as well as appeals to the E.U., the Oropos activists drew public attention to the pollution. In 2009 they held a demonstration outside the Greek parliament, where they handed out samples of river water to passers-by.[6]

Distrust of the Greek government and their agencies made the Asopos activists avoid official channels, but they were successful in engaging the media. Both SKAI television and the national newspaper Kathimerini played an active role in the campaign. The Medical Association of Thebes, the Association of Greek Chemists, the Greek Geological Institute and the Technical Chamber of Commerce supported the movement with technical expertise. Internationally, Erin Brokovich's website and Friends of the Earth were supportive. The major political parties did nothing to help the campaign, but the emergence of a Green Party gave such environmental organizations a minor voice in parliament and helped get their message to the E.U. In Mediterranean countries such as Greece, where there is serious distrust of government agencies, the ability of local activists to communicate their concerns to the higher authority of the E.U. is crucial. In 2009, a delegation of Asopos activists attended a conference at the European Parliament wearing T-shirts that spelled out the name of the river (Fig. 4).[7]

The E.U. has accepted that hexavalent chromium is a serious toxin and should not be found in drinking water, and is presently engaged in a two-year study to determine what maximum safe amount, if any, is acceptable. In 2009, the Greek Environmental Ministry suspended the registration licenses of two firms but the state record on water pollution has been abysmal. In the midst of the worst economic crisis in Greece since World War II, the government is under enormous pressure to increase revenue by any means possible. Encouraging new industries without monitoring their impact on the environment and selling off natural assets, including water, have been strategies to gain revenue and pay off enormous debts to the "Troika"(the IMF, the E.U. and the World Bank).[8]

The Acheloos, Greece: "Our Great Victory"

The failure of local and international attention to effect change in the case of the Asopos River made some environmentalists despair about the possibility of influencing water policy in Greece, but under the leadership of the World Wildlife Fund (WWF), green activists have recently achieved a surprising victory. Eighty years ago a proposal was made to divert the waters of the Acheloos River in order to irrigate the fields of Thessaly, where cotton is the main crop. The headwaters of the Acheloos are in the Pindus Mountains in Central Greece, and the river flows westward to the Ionian Sea. The south end of Pindus Range separates the Acheloos from the Thessalian Plain. Like the plan to divert the Ebros River in Spain (see Ch. 4), the diversion scheme has been controversial ever since it was first envisioned in the 1930s, and became more so in the last decade as environmental awareness has grown in Greece (Fig. 5).

Conceived as a project that might boost the depressed economy of northeastern Greece, the project was abandoned for lack of funding. World War II, during which Greece was occupied by the Germans, and the civil war that followed put an end to all such projects for a decade, but from the 1950s to the 1980s, a number of hydropower dams were built on the Acheloos. In 1984, the Greek government decided to revisit the plan for diverting the river to the east of the Pindus Range. The project was ambitious, involving the construction of large dams and reservoirs at several sites, the 17.5-km Sykia diversion channel to Thessaly, and two longs tunnels. Together, the dams, reservoirs, and tunnels would carry approximately 6 billion cubic meters of water from the Acheloos and its tributaries to the eastern side of the range.

Four years after the government made its proposal, the Ministry of National Economy called in the U.K. banking firm of Morgan Grenfell to make a cost-benefit analysis for the scheme. The firm concluded that even in the best-case scenario of work being completed on schedule (always a dubious proposition in Greece), the financial viability was low. Nevertheless, despite the E.U. reduction in support for agricultural growth, the Greek government approved the environmental impact study they had commissioned for the two largest dams and applied for E.U. funding for their project.

Economic concerns and increased restrictions were matched by growing environmental awareness both inside and outside Greece. Under the E.U. Birds Directive (79/409/EEC), the Acheloos River and its delta are listed as special protection areas, and the area of wetlands surrounding the Missolonghi lagoons of the delta is one of eleven Ramsar sites in Greece. The upper sections of the river are also the most important habitat for the *Salmo trutta*, a species of trout protected by the E.U. Habitats Directive. The construction of dams along the route that trout take upstream to breed was regarded as likely to have a major effect on the fish population.

FIGURE 5

The Acheloos River near Oiniadai, Greece. Photo: Dan Diffendale, 2012.

Detrimental environmental effects were predicted not only for these and other species of wildlife, but for the land itself, causing erosion and possible landslides. The eleventh-century monastery of Mirofyllo would be a cultural victim of the scheme.

In a movement that seems to mark growing strength and unity among Greece's environmental groups, WWF Hellas, Greenpeace, and others accused the government of squandering funds and stated that the project would mark "a continuation of the catastrophic water management and unacceptable agricultural practices that have been undermining the Thessaly Plain for years" (water-technology.net, n.d.). Although the minister of the Environment and Public Works, George Souflias, had claimed the plan was environmentally sound, the European Commission (E.C.) refused to fund the diversion and in 1994 the highest court in Greece annulled the ministerial decision to go ahead with it. The Greek government defied the ruling and went ahead with the construction of the Messochora Dam but modified the overall scheme, reducing the quantity of water that would actually be available to irrigate additional crops to zero. Farmers in Thessaly were not informed of this, and the Greek government continued with its scheme with support from the ministry.

In 1995, the environmentalists again presented their case to the E.C. and a restraining order was issued which stopped work on the project until a formal hearing could be held. In November 2000, the E.C. cancelled the ministry's approval, and work stopped on the project for two years, during which the farmers of Thessaly continued to lobby the government to restart it. A major crop in the region is cotton, a water-thirsty crop that has been subsidized by the E.U., but may soon be unviable as the E.U. phases out subsidies.[9] The Greek government, to no Greek's surprise, bowed to the farmers' pressure and refinanced the project with €210 million taken from the national budget. Work began again in 2003 and stopped in 2004, perhaps for financial reasons, but the government passed legal amendments to allow it to continue. The coalition of Left Movements and Ecology (Synaspismos) was opposed to the measure, but it was the coalition of environmental groups, led by WWF, that finally achieved a twenty-year moratorium on the Acheloos diversion project in January 2014.[10] In what they termed "Our great victory," WWF Hellas described their twenty-year campaign to defeat the diversion, and praised the coalition of various environmental groups, communities, and municipalities that had cooperated to defeat the Greek government's plan.

The victory of the Acheloos river campaign is a promising one for future water management in the European Mediterranean. It underlines the importance of international agreements on environmental protection. However much they are disobeyed (and Greece has been an egregious offender in this area), there are serious financial consequences for disobeying E.U. laws. It also injects energy and optimism into the environmental movement in countries like Greece where, until recently, it seemed to have little effect on the national government and powerful lobby groups associated with it.

TRANSBOUNDARY RIVERS

The four rivers I took as examples of how social activism can affect policy and cause real change are all national ones. Most rivers in the Middle East and North Africa take no notice of national boundaries and flow between and across them. These rivers present even bigger challenges for the agents of environmental change. The Nile has eleven riparian nations, and the problems of allocating its resources in any equitable way involve political, economic, and social issues of unimaginable complexity. The Jordan River's meager flow is shared by Israel, Jordan, Lebanon, Palestine and Syria, but Israel takes the lion's share, and is unlikely to relinquish a drop. The Kidron River, which runs from the Old City of Jerusalem through the West Bank to the Dead Sea, may not contain hexavalent chromium, but its waters flow through East Jerusalem, Bethlehem, and Ubeidiya, collecting untreated sewage from Palestinian villages and Jewish settlements and dumping it into the Dead Sea. A master plan headed by Richard Laster, a Law Professor at the Hebrew University, has suggested diverting the water from the Kidron Valley to a sewage treatment plant, to be jointly constructed by Israelis and Palestinians in the impoverished town of Ubeidiya (Wheelwright 2013). Of course the obstacles to this very sensible solution to the pollution of the Kidron are political. To fix the problem would demand not only considerable investment, but a level of cooperation between Israelis and Palestinians that is difficult to imagine, at least in the near future.

So not only is it difficult to achieve a consensus about sharing the resources of rivers within national borders, but it is exponentially more complicated to agree about how to share and conserve the quality of international bodies of water. Gestures, small and large, are needed to change the situation: international agreements, like those reached by GWP-Med with riparian nations on the Drin River in the Balkans (See Ch. 6),[11] public education, international environmental legislation, social activism, and water museums like those recently established in the Cypriot capital Nicosia by the local water board, on the Greek island of Hydra, and the Venice Water Museum discussed by Eriberto Eulisse in Chapter 1.

One of the most surprising projects to emerge from our work on water in Greece is a children's musical theater piece. The well-known Greek singer Mariza Koch organized a series of concerts with local children during our travels to various sites where there were water problems. The concerts achieved their aim of attracting a large audience to our meetings. Mariza decided to develop her interest in conserving water by writing a children's show that would unite her love of traditional song with a message about the need to respect and save water. The show was called "The Quilt with the Golden Bells" and has been presented to thousands of children over the last three years. It was turned into a children's book in 2011 (Koch 2011). The story combines a traditional tale of St. George and the Dragon with a contemporary story about a dragon that lives in a well near the new Acropolis Museum, and steals a quilt to keep itself warm. The quilt is covered with a thousand golden bells, each containing an old Greek song (Fig. 6).

FIGURE 6

Illustration from Mariza Koch's book *The Quilt with the Golden Bells*. Source: Mariza Koch, 2011.

FIGURE 7

Mariza Koch performing "The Quilt with the Golden Bells", Benaki Museum, Athens. Photo: Mariza Koch, 2012.

In the show the children are invited to strike a bell on the quilt and are rewarded with a song played by the musicians and sung by Mariza (Fig. 7). One is an old ballad from Cappadocia that talks of a dragon that has come to live in the village well and demands the villagers sacrifice a child each day before it will allow them to draw water. The lot falls to the king's daughter, who willingly goes to sacrifice herself for the good of the town, except that St. George appears just in time to slay the dragon, marry the princess and restore the town's water. During the show Mariza talks to the children about the message of the song: how precious water is and how we must preserve it from harm.

When individual artists like Mariza Koch teach children about the need to preserve water the results of her intervention can never be assessed. Like the water museums, the benefits are intangible and difficult to measure. When Pete Seeger began his Clearwater campaign, he already had followers who were active in opposing official policy on other issues. Environmentalism was in the air and he knew how to mobilize his followers. Environmentalism is now internationally powerful and national governments must at least pay lip service to it. Obviously the countries of the Middle East and North Africa have none of the resources of a civil society that made the Clearwater campaign such a success, but even at the turn of the twenty-first century in Greece, grass-roots mobilization for environmental change seemed impossible. It is even more remarkable that water activists were able to achieve their victories in the midst of the most serious economic crisis in Greece since World War II. The protests of environmental activists in Istanbul in the summer of 2013 were met with a violent government crackdown, but not before the international press had given the young Turkish protesters extensive coverage. The extraordinary social movements taking place across the region in the last few years have not all been in vain; they have drawn attention to the discontent and anger of vast populations facing poverty, injustice and the inequitable distribution of resources. The demand for environmentally responsible action to preserve or clean up rivers is still a recent phenomenon, and it will be slow to expand in countries where poverty and politics dominate society, but it is certain to grow.

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ENDNOTES

1. According to the Griffith Area News, the buybacks are estimated to have stripped about 800 jobs and $100 million from the local economy so far (Jennings 2011).
2. Originally a project to link widely scattered communities throughout the basin, the website of the centenary of the project (oneriver.com.au) describes multiple contemporary projects created to draw attention to the river as a single, endangered waterway.
3. See www.brockovich.com, accessed 12 February 2014.
4. According to Yannis Ktistakis, speaking at a press conference in Athens in June. Ktistakis was the author of the complaint to the committee.
5. For more information about activism surrounding the Asopos River, see Passali, 2009.
6. For more information, see http://environmentfood.blogspot.com/.
7. See http://environmentfood.blogspot.com/.
8. Conditioning loans based on full or partial water privatization is an increasingly common practice of international lenders. In June 2010, the Greek Ministry of Finance announced that through the Hellenic Republic Asset Development Fund, the Greek government would reduce its shares in EYATH and the Athens State Water Utility (EYDAP), from 74 percent to 51 percent. Since then, the ministry has adjusted the target, planning to sell off 100 percent of its holdings in the two state companies. Today, approximately 21 percent of EYATH trades on the Athens stock market. In the case of Greece, the pressure from international leadership is so strong that democracy is hardly an issue. Despite large-scale opposition to the proposed privatization of water, under the leadership of "Initiative 136", the government has so far been deaf to pressure.
9. See E.U. motion for a resolution B7-0492/2013. Available at http://www.europarl.europa.eu/sides/getDoc.do?type=MOTION&reference=B7-2013-0492&language=EN, accessed 11 February 2014.
10. See WWF: «Μια μεγάλη μας νίκη μετά από 20 χρόνια». (Our great victory after twenty years) http://wwf.gr/enimerotika/acheloos/image.jpg
11. On 25 November 2011 in Tirana, Albania, the five Drin River riparians signed a Memorandum of Understanding on a Shared Strategic Vision for the Sustainable Management of the Drin River Basin for the benefit of about 1.5 million people relying on the water resources of the basin for drinking water, agriculture, fisheries, industry, and hydropower. See GWP, 2011.

A night view of the Nile Delta and the Eastern Mediterranean Basin. Photo: NASA, International Space Station, 2012.

8. Water Preservation Perspectives as Primary Biopolicy Targets

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Up to about two years ago, world experts and negotiators were aiming to limit global warming to less than 2°C. Today, we are already witnessing 3°C changes, with unfathomable consequences for the continuation of life on our planet. Scientists now predict that further melting of polar ice caps in Greenland can lead to the release of enormous quantities of methane gas with a resulting 4°C rise in temperature and a seven-meter rise in sea level.

Water made the evolution of life possible. Acting both as a proton donor and acceptor, water became an ideal medium for the biochemical reactions in cells and thus facilitated the formation of the planet's early life forms, while also protecting them from the sun's harmful rays. Once the first aquatic photosynthetic organisms appeared, free oxygen entered the atmosphere. The combination of single oxygen atoms with oxygen molecules led to the formation of the ozone layer, which changed the conditions of natural selection for all organisms on our planet and allowed the propagation of life on land. Water also promotes life in numerous other ways and serves as a powerful moderating influence on the world's climate. We need to appreciate and value these remarkable properties of water in order to face the unprecedented challenges of climate change mitigation.

With the progress of technology, the *macrocosmos* and *microcosmos* are no longer a mystery. On a cosmic scale, we know of no other planet in the universe where life exists. This makes it all the more urgent to elicit a global commitment to protect the continuity of *bios* – all life on our planet. But on the microscopic level as well, the world of the cell unravels an infinite potential for humanity and consolidates the marvel of this unique gift. The revelations are dazzling: 650 trillion molecules of hemoglobin are produced every second in the human body. We cannot grasp this measurement in a single lifetime, yet, besides hemoglobin, thousands of other proteins are produced by the millions in every cell, providing just a small example of what is taking place every fraction of a second in every living organism. And yet, our arrogance prevents us from appreciating this miracle and we continue to be caught up in a dangerous web of environmental abuse.

The alarm call that spurred the Biopolitics International Organisation to launch the International University for the Bio-Environment in 1990 was a documentary on the Adriatic Sea and what has been happening to our planet's water systems. At one point, the camera dives from the polluted surface into deeper waters and a frightening picture is revealed. Not a single form of life is visible in a radius of several kilometers. Only a jellyfish can be seen swimming in the distance. In terms of biology, a jellyfish represents one of the earliest stages of evolution, and this destruction indicates how far into the past our negligence can swing the pendulum of evolution.

If our planet is to survive, inspired leadership is urgently needed. Can we hear the ticking clock of destruction? Our planet is only a speck of dust in the universe, yet we continue to divide it up in even smaller specks. What is the excuse for such a deep division of humanity?

Education is key in spurring change and in ensuring that we can guide technology with a new vision. Presently, technology provides the opportunity for every individual to participate in the race to save the environment. The "bio-assessment of technology", with a thesis, antithesis and synthesis of new values, can help us to apply the life-supporting aspects of progress to clean the oceans, protect aquatic ecosystems, and ensure safe and adequate water resources. Every individual needs to be engaged in climate change mitigation, since a dying planet cannot become the global legacy we leave for future generations.

We are at a critical juncture, and time is of the essence. Climate change does not only imply enormous threats to water resources and biodiversity; society as a whole will be seriously affected. Extensive catastrophes, such as floods and droughts, desertification and the melting of polar icecaps, will compromise livelihoods and public health, and create enormous social problems that we cannot even begin to imagine. Water scarcity, hunger and the spreading of new diseases will lead to unprecedented waves of migration, economic uncertainty and social unrest.

Security cannot be achieved on a planet of waste and destruction. What is urgently needed is a common strategy, a global defense protocol against climate change. We must focus on the value of differentiation as a source of enrichment. Differences in religion, culture, language, and biodiversity are the wealth of humanity. "Bio-defense", and its parent concept, "bio-diplomacy", or international cooperation in environmental protection, are based on interdependence and collaboration. Just as all the parts of the human body need to function together in harmonious coordination to maintain a healthy individual, modern society desperately needs a common vision to secure a harmonious and peaceful future.

The world's dwindling water resources need bold plans of action for international cooperation. Nations must declare war on environmental destruction and abuse. Foreign policy should shift from a fragmented, competitive framework to a vision of unity and interdependence. The greatest task for the twenty-first century will be the permanent reconfiguration of defense infrastructure into programs for the defense of the planet. Competition to find better methods to destroy life should be replaced with cooperation to find ways to save it. Time is of the essence, and this new vision is urgently needed.

Society is experiencing a deep crisis: economic, environmental, and above all, a crisis in leadership. The evidence of global warming is clear and affects everyone. Climate change mitigation policies will succeed or fail by the everyday actions of empowered and capable individuals, communities and countries. Maybe the time has come for a World Referendum for the billions of people on the globe to vote simultaneously to save all life on our planet.

The role of the media is vital in this context. Rather than disseminating negative messages and primarily focusing on wars, disasters, and human suffering, the media everywhere need to converge on the positive aspects of life and urge world leaders to engage in a constructive dialogue promoting transparency and justice. True democracy also needs an ethical commitment from decision makers in every field to promote policies that respect all life on our planet. To help society exit the crisis in values, leaders should not sustain the mistakes of the past, but have the courage to build a society of joy and the needed vision for a harmonious future.

This article is an abridged version of Dr. Vlavianos Arvanitis' keynote speech at the 'Water Scarcity, Risk and Democracy in the Mediterranean and Beyond' conference, which was held at the Cultural Center of Athens, 12-13 April 2013.

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Once the Prophet Mohammed asked a person, who was performing Wudu: "Why are you wasting water?" The person enquired: "Is there waste even in Wudu?" The Prophet Mohammed replied: "Yes indeed, (do not waste) even if you are at the bank of a river."

IBN MAJAH

Rabbi Tanhum ben Hiyya said, "The falling of the rain is greater than the giving of the Torah, for the giving of the Law was a joy only to Israel, while the falling of the rain is a rejoicing for all the world, including the cattle and the wild beasts and the birds."

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9. Leaving the Land: The Impact of Long-term Water Mismanagement in Syria

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KEYWORDS: SYRIA, WATER SCARCITY, WATER OVEREXPLOITATION, EUPHRATES BASIN PROJECT, GROUNDWATER DEPLETION, INTERNAL MIGRATION

Abstract

This article examines the impact of long-term water and land mismanagement on local communities and individuals in Syria during the period 2006-10, highlighting the startling depth and breadth of the environmental damage inflicted over the last sixty years. The failure of large-scale agricultural development projects combined with economic policy reforms in the 2000s had far-reaching social repercussions, undermining farmers' livelihoods, dislocating rural communities, and driving migration to urban centers and Lebanon.

INTRODUCTION

The general state of water resources in Syria and the overall impact of current and future water scarcity in the Middle East and North Africa (MENA) region have been discussed extensively (Salman and Mualla 2003; Sagardoy and Varela-Ortega 2001; World Bank 2007). However, comparatively little attention has been paid to the smaller-scale impact of the decline of freshwater resources on individuals, communities, landscapes, and local environmental conditions. This article aims to give a micro-level view, focusing on the human impact of long-term water and land mismanagement in Syria by scaling down to the level of personal accounts from across the country.

Drawing on research carried out in 2006-10, it presents a snapshot of pre-conflict Syria and highlights the startling depth and breadth of the environmental damage inflicted over the last sixty years. This has obviously had far-reaching social repercussions, undermining small and medium-scale agricultural businesses, dislocating rural communities, and forcing farmers to seek new sources of income, often in other parts of the country or abroad. Reading between the lines of the conversations I had with farmers, water experts, and government officials over a five-year period, growing feelings of anger, frustration, and powerlessness became apparent as Syrian farmers saw their livelihoods disappear and landscapes irreversibly destroyed, mainly as a result of mismanagement and a lack of coherent policies and law enforcement.

The article is divided into two sections. The first provides a brief summary of Syria's agricultural and water policies since 1960, with a focus on the rural northeast of the country where the ambitious Euphrates Basin Project, a massive hydropower and irrigation scheme that included the construction of three dams on the Euphrates River, has profoundly transformed landscapes, land and water use patterns, and social structures. However, despite massive government investment in the project – a quarter of the national budget for twenty years (Ababsa, 2011: 88) – it never even came close to meeting

FIGURE 1

The village of Tel al Banat was one of the dozens of villages that was flooded after the construction of the Tishreen Dam. Photo: Adel Samara, 1999.

its objectives and the northeastern governorates remained the least developed in 2009, with high poverty rates, low healthcare levels, and high illiteracy (Sands, 2010).

The second part focuses on the specific case of the village of Tel al Banat, which lies on the banks of the Tishreen Dam reservoir. Interviews with villagers from 2009 reveal the far-reaching impact of the scheme, which displaced the village from the Euphrates Valley and left its inhabitants scattered across the country in "new villages" in the government irrigation projects, tent camps in the Damascus suburbs and disused buildings and sheds in Lebanon (Fig. 1). Interviews in this section show that the depletion of water resources was already a problem in the late 1990s, and that farmers from the Euphrates Basin, but also Idlib and Hassakeh Governorates, were gradually forced to abandon agriculture. The article concludes with a brief discussion of possible links to the start of the Syrian uprising in March 2011 and the role of water management in Syria's future.

SYRIAN AGRICULTURAL AND WATER POLICIES SINCE 1963

While the Syrian government has been keen to ascribe growing problems of water scarcity to high population growth, growing water demand, the unequal distribution of water resources in the country, and climate change, Barnes (2009) has shown that scarcity in Syria has been constructed and is a direct product of the Syrian government's promotion of irrigated agriculture and the desire to attain self-sufficiency in the main agricultural staples. From the time the Ba'ath Party came to power in 1963, agriculture was its main focus. Due to its strong roots in the rural areas, the party prioritized the development of the agricultural sector and promised to redress the imbalance between the political and economic elite and the marginalized class of workers and peasants. First of all, it introduced a far-reaching land reform program for the benefit of landless farmers and secondly, it channeled huge investment into large-scale, centrally managed irrigation schemes, with large dams, ambitious land reclamation targets and wide support for the development of groundwater resources. The state's strong ties to its rural support bases was further strengthened after President Hafez al-Assad came to power through an internal coup in the Ba'ath party in 1970. Originally from a rural village in the Coastal Mountains near Lattakia, Assad highlighted his peasant origins and cultivated an image of himself as a "one of the people." In a speech on 8 March 1980, Assad said: "I am the first and the last... a peasant and the son of a peasant. To lie amidst [stalks] of grain or on the threshing floor is, in my eyes, worth all the palaces in the world" (Barnes 2009: 521).

The Ba'ath party nationalized much of the economy and introduced a central planning strategy for agriculture, with heavy subsidization of "strategic crops" such as wheat, barley, sugar beet and cotton. Syria prided itself on its agricultural development and self-sufficiency in certain staples. Until the incidence of a severe drought in 2007, Syria was even one of the only Arab countries to export wheat, with an average annual production of 4.25 million tons for the period 1998-2007. Moreover, it more than doubled the country's irrigated surface area from 651,000 ha in 1985 to 1,4 million ha in 2011 (NAPC 2013).

But the massive investment in irrigation projects and agricultural development failed to provide the promised returns, both on a financial and non-financial level. Elhadj (2005) calculated that the government spent about $20 billion on agricultural projects between 1960 and 2000, the equivalent of 20 percent of the country's total investment resources. In the period 1995-2000, it allocated 3.3 percent of the country's GDP to agricultural projects, which generated a loss of $150 million or $1,087/ha. Non-financial returns were also poor as Syria remained dependent on the country's capricious rainfall patterns, rural to urban migration continued to grow and – except for wheat, barley, and eggs – food independence was not achieved. On the other hand, the government's policies depleted large volumes of Syria's limited water reserves. By 1997, five of Syria's seven water basins had a negative water balance, while the quality of the remaining reserves had been degraded (Elhadj 2005: 33). In the decade between 1995 and 2005, annual per capita water availability decreased from 1,791 m^3 to 882 m^3 (FAO 2009), placing Syria below the water scarcity line of 1000 m^3 per person per year – a decline which mainly reflects the rapid population growth in the country, but also decline in available water resources. In 2007, the country – traditionally one of the most water rich in the region after Iraq and Iran – had a water deficit of an estimated 3.59 billion cubic meters, which was made up for through the use of water from dam reservoirs and groundwater reserves (GTZ & SPC 2009).

Yet despite the clear signs that the country's water and land resources were overstretched, the government continued to pursue an agricultural strategy aimed at further increasing production and expanding the irrigated surface area. A 2001 Ministry of Irrigation report outlined new plans for the construction of more dams and the reclamation of nearly 500,000 ha of land in five of the country's seven basins at a cost of around $2.42 billion.[1] This amount is almost equal to the investment in irrigation between 1988 and 2000 (Elhadj 2005: 137). While certain agricultural policies were adjusted – the cultivation of water-intensive crops like cotton and sugar beet was forbidden in certain governorates (Shamali 2009), summer irrigation was banned and new laws aimed (but failed) to prevent illegal well-drilling and modernize irrigation systems – no concession was made to the strategy of food self-sufficiency and, more specifically, wheat self-sufficiency. In meetings with government officials and water experts between 2006 and 2010, I was repeatedly told that interfering with the wheat policy was a "red line."

Moreover, despite evidence that much of the land in the northeast of the country was not suited for intensive cultivation, the government continued to reclaim new land. Thus in March 2011, the Syrian government launched a $2.1 billion mega-project on the Tigris River in Syria's far north-east that aimed to pump an annual 1,25 billion cubic meters of water to irrigate 200,000 ha of land in Hassakeh Governorate (Ibrahim and Razzouk 2011). In addition, several new hydropower dams were being planned and built on the Euphrates and Orontes Rivers, providing electricity and irrigation water to new cropping areas in the north and east of the country. All these projects have obviously been halted since the outbreak of the conflict in Syria, but they underscore the Syrian government's inability to adapt to changing environmental and economic realities. "Once the wrong strategy is put in place it becomes progressively more difficult for the government to reverse the policy [...]. Modifying a wrong strategy is like slowing down on a road which is going in the wrong direction." (Elhadj 2005:38)

Effectively, Syria's agricultural sector was structured around the abstract framework of food self-sufficiency, strategic crops and subsidies, rather than the reality of economic or environmental constraints. "...Syria's political leaders paid little attention to sound economic planning. They focused on short-term political solutions, ignoring the fact that their country does not possess sufficient and reliable water [resources]" (Ibid.: 142).

THE PROMISE OF THE EUPHRATES BASIN PROJECT

Until the 1980s, the sustained drive for agricultural growth improved living standards in rural areas, but this trend slowed in the 1990s as the limits of land and water resources were overstretched, particularly in the north and east of the country. Thus while Syria prided itself on its self-sufficiency in certain main staples and on its wheat exports, 11.4 percent of its population lived in extreme poverty in 2005, unable to satisfy its basic food and non-food needs (UNDP 2005).

Nonetheless, agriculture remained the largest sector throughout the 1990s and retained a prominent role even as the oil and industry sectors expanded. It remained the backbone of the rural economy in the 2000s, even though the agricultural labor force was halved to 15 percent between 2000 and 2010. Despite the impact of drought in the late 2000s which reduced agricultural exports, the agricultural sector accounted for about 20 percent of Syria's GDP in 2010 (The Syria Report 2013). But farmers and herders were increasingly forced to abandon agriculture even though there were few employment alternatives, especially in the impoverished northeast of the country where illiteracy rates were the highest.[2] This was also the only place where poverty levels had increased in the period between 1996 and 2004, with 58 percent of the country's poor living in this region (UNDP 2005).[3] These disparities were exacerbated after 2000, when Bashar al-Assad acceded to power after his father's death and started implementing policies to liberalize the economy and open Syria up to world markets. Ba'athist policies were abandoned and in 2005 the government announced a transition to a social market economy, which led to the cancellation of a number of state subsidies including those on fuel and fertilizer in 2008 and 2009. These subsidy cuts coincided with a four-year drought between 2007 and 2010, which had a devastating impact in the northeast (De Châtel 2014). Agriculture remained an important economic sector, but the government was much more focused on attracting foreign investment for the development of trade, housing, banking, construction, and tourism. Moreover, despite nominal government efforts to attract investment to the northeast, economic activity remained concentrated in the two large cities, Damascus and Aleppo, and along the coast (Fig. 2).

Yet forty years earlier, the Syrian Ba'ath party had invested heavily in the development of the agricultural sector in the northeast of the country, also known as the Jezira,[4] where it had aimed to

FIGURE 2

Map of Syria. Source: Ghazal Lababidi, 2013.

create the new model of a socialist society. With encouragement and substantial financial support from the Soviet Union, the Syrian state embarked on a large-scale irrigation and reclamation project that would transform agriculture in the Euphrates Basin from small-scale irrigation and dryland farming into massive agricultural projects, with large-scale irrigation and drainage systems (Springborg 1981).

The Euphrates Basin Project that was launched in 1968 was a showcase of Ba'athist development policies. Among its ambitious goals, it aimed to regulate the water of the flood-prone Euphrates River,[5] boost agricultural production through the creation of 640,000 ha of new irrigation areas, and generate 2.5 billion kW/year of electricity to run irrigation pumps, power local industry and electrify villages. The project's centerpiece, the Soviet-funded Tabqa or Thawra Dam, was among the world's ten largest. Even before it was completed in 1973, it became an emblem of Ba'athist power, a fact that was affirmed when the dam reservoir was named after President Hafez al-Assad (Hinnebusch 1989). The Euphrates Basin Project became a main priority for the regime, which dedicated 25 percent of the national budget to the project for more than twenty years (Ababsa 2011: 88).

The project also had clear socio-political goals, aiming to instigate social change in the backward eastern provinces and gain political control over the unruly Jezira region by breaking down the strong tribal structures and constructing a new progressive rural society based on socialist methods of cooperative production and state farms (Ababsa 2005: 17). The filling of the Tabqa Dam reservoir in 1973 flooded 250,000 ha of arable land, sixty-six villages and hundred twenty-six hamlets in the fertile Euphrates Valley, displacing between 65,000 and 75,000 people. The government planned to resettle this population on fifteen model farms in the pilot irrigation project, dispersing the displaced from each village across several farms in an effort to sever tribal ties (Ababsa 2011: 94). However, poor design and lack of space in these new villages made them unattractive to the communities from the Euphrates Valley who strongly resisted the move. In the end the government offered to resettle them in the forty-two newly built villages[6] in the Khabur Basin in Hassakeh Governorate. Around a third of the displaced population made the move to Hassakeh, while only 9 percent settled in the pilot project's state farms. Many more (around 55 percent) remained in the area and built new villages in the steppe lands on the edge of the new dam reservoir. Some of them were herders with large numbers of sheep who would not have had enough space in the new villages and farms; others were landless or could not prove ownership of their land in the valley. Many also moved to Raqqa, Aleppo or Damascus (Hinnebusch 1989: 236, Ababsa 2005: 18, Rabo 1986: 35).

Like many other "hydraulic mission" schemes of its type, the Euphrates Basin Project failed to meet its targets, which were often unrealistic. As in Egypt, where the Soviet-backed construction of the Aswan High Dam did not achieve far-reaching agricultural transformation, the Tabqa Dam did not turn agriculture in Syria into a highly profitable enterprise. The annual reclamation target of 50,000 ha set by President Hafez al-Assad was never attained, let alone the ultimate goal of 640,000 ha (Springborg 1981). Unexpected ecological problems posed serious challenges, slowing the pace, increasing costs, and considerably reducing the project's scale. The salt content of the Euphrates increased after irrigation started in southeastern Anatolia in Turkey and this combined with the hot, dry conditions, and rising groundwater levels made soil salinization a constant problem (Hinnebusch 1989). The problem of soil salinization in the Syrian Jezira was further exacerbated by the gypsiferous soils in this area, which have a high potential for salt mobilization (UN-ESCWA & BGR 2013). Between 1976 and 1985, 4,000 ha of arable lands became salinized every year and by the early 1980s 20,000 ha had been lost to salinization and a further 35,000 ha had lost half its productivity due to salt formation (Ababsa 2011: 91). Furthermore, dissolution of the gypsum bed material in the irrigation canals caused the collapse of irrigation structures (Furley and Zouzou, 1989) and made reclamation uneconomic. As a result, only 60,000 ha were irrigated from Lake Assad by 1984 (Collelo 1987). In 2000, the irrigated surface had risen to 124,000 ha, less than 20 percent of the projected 640,000 ha (Elhadj 2008).

FIGURE 3

Children in Maskaneh, a village in one of the seven Euphrates Basin government irrigation schemes in Syria. Photo: Adel Samara, 2009.

The state farms, designed as "'avantgarde' structures to train farm laborers with modern techniques of production and to diffuse the Ba'ath Socialist ideological principles" (Ababsa 2011: 88), failed from the time of their establishment in the 1960s, both from an economic and social point of view. Costs were higher than revenues and productivity remained low. In 2000, the income of all state farms in the Euphrates Project was SYP 25.5 million ($0.57 million) while production costs reached SYP 645 million ($14.3 million) (Ibid.: 94-95).[7] Overall costs also far exceeded initial projections, as a result of international inflation and the other unforeseen complications. The cost of reclamation had been estimated at SYP 2 billion ($500 million), but by 1977 cost estimates had been adjusted to SYP 13-14 billion ($3.25-3.5 billion) not counting the cost of population resettlement. In comparison, the construction of the dam and the adjacent town of Thawra had only cost SYP 1.4 billion ($350 million) (Hinnebusch 1989).[8] The dam itself had also failed to meet planners' optimistic expectations so that two additional dams, Al Baath and Tishreen, were built in 1986 and 1999 respectively to provide additional flood regulation and hydroelectricity.

A FLOOD AND THREE DROUGHTS (TEL AL BANAT, 2009)

The recent history of Tel al Banat, a hamlet on the Euphrates that lies around 100 km upstream from the provincial capital Raqqa, illustrates the far-reaching social repercussions of the Syrian government's infrastructural and political projects in the Jezira region over the last fifty years. The original Tel al Banat hamlet was flooded by the construction of the Tishreen Dam and the creation of Lake Tishreen, and its inhabitants were scattered across the country. Some moved to the newly

FIGURE 4

Villagers take down their houses in Tel al Banat before the flooding of Lake Tishreen on the Euphrates in Syria. Photo: Adel Samara, 1999.

reclaimed lands in the Maskaneh Pilot Project, one of the seven Euphrates Basin government irrigation schemes situated about 200 km southwest of Tel al Banat in a vast dusty steppe (Fig. 3). Others moved to Raqqa or the Damascus suburbs. Around fifty families remained in the area and rebuilt their homes on the banks of Lake Tishreen on the edge of the steppe. Their reasons for staying were diverse: some could not prove ownership of their land in the valley and therefore received no new lands in the Maskaneh project; others received such small plots in Maskaneh that they could not have made a living. Farming and settlement are officially forbidden on the government-owned lands around Lake Tishreen. But local communities all around the lake have stayed, illegally cultivating the land and pumping irrigation water from the lake. The story of Tel al Banat is characteristic of many of the flooded villages of the Euphrates Valley whose population was uprooted and scattered through Syria and Lebanon after 1973.

Ahmed al Yehya, a forty-five-year-old farmer whose family had lived in Tel al Banat for generations, remembers that the flood came very suddenly: "We had been hearing about it for ten years and then suddenly, within a week, it was there. We took whatever we could before the old family home disappeared in the water, even the wooden roof beams, and pushed it up the hill in carts (Fig. 4). Some people didn't want to leave. They were going to lose all their belongings in the flood. They said they would rather die in the flood than move to the new lands in Maskaneh. And some did. My father had a heart attack and died on the day of the flood."

Like many other farmers in the Euphrates Valley, Yehya's family could not prove ownership of their land. They only had the deeds to the land on which their home was built, which made them eligible to a 0.4 ha patch of land in Maskaneh. This would have had to be shared out between five brothers. "Only one of my brothers moved to Maskaneh, the three others are in Damascus. I am the only one who is still here. We are now illegally on this land" (Fig. 5). Yehya said the land outside of the valley was much poorer. "I think that within twenty years it will be useless. People who started farming olive trees five years ago have had to abandon the land because the trees are dying. There are thousands of hectares of dead salinized land now. The land that was flooded by the dams yielded twenty times more than the land here or in the area of Maskaneh. This land is poor from the outset, so how are you going to make it productive? An old lady won't ever be a bride, even if you put make-up on her."

By 2009 the farmers of Tel al Banat and the wider Jezira region were facing the third consecutive year of drought and drastic cuts in fuel and fertilizer subsidies, a lethal combination that was forcing many to abandon their land (De Châtel 2014). Three quarters of the houses in Tel al Banat were boarded up after families had left. They chose Damascus and the southern governorates more than 600 km from the Euphrates Valley instead of nearby Aleppo. "Aleppo is full," they said, with migrants who could not find work. Not that they had any expectations of life in the capital. "Damascus is the mother of the poor." They knew life there would be worse than in Tel al Banat, but life there had become impossible.

LEAVING THE LAND

Hamouriyeh, Damascus Countryside Governorate

Ahmed al Yehya's brother, Mahmoud Hamadeh, locked up his house in Tel al Banat in 2008 and moved to the Damascus suburb of Hamouriyeh. He rented a plot of land for SYP 1,500 ($31.90) a month and lived in a woolen Bedouin tent with his wife, eight children and two daughters-in-law. His wife and daughters-in-law worked on nearby farms and his sons tried to get odd jobs as builders and porters in neighboring suburbs. "We have faced many difficulties since we came here," he said, sitting outside his tent by the roadside. "It is not as we expected it to be. There is no work here either, but we had no choice but to leave Tel al Banat. We had to eat" (Fig. 6).

Hamadeh's tent bordered on a larger plot of land where three or four families from the Euphrates Valley had been living in squalid conditions since the flooding of Lake Tishreen in 1999. Like thousands of others, they had been unable to prove ownership of their lands and had lost everything when the Euphrates Valley was flooded. Instead of staying in the area though, they had taken their chances and moved to Damascus in the hope of finding a better life. But ten years later they still lived in a haphazard collection of tents and shacks that had been drawn up around a central yard. Half-naked children played in the mud, women filled large plastic vats with water that they had bought from a private vendor (Fig. 7). Like Hamadeh's family, these families survived by finding temporary farm and construction work. None of the children went to school; their parents could not afford the 10 SYP ($0.20) return bus fare, or the notebooks, pens and shoes they would need. Moreover, the children were more useful if they worked to help support their families.

FIGURE 5

Ahmed al Yehya in his home in the new village of Tel al Banat on the shores of Lake Tishreen, Syria. Photo: Adel Samara, 2009.

FIGURE 6

Mahmoud Hamadeh left his home in Tel al Banat in 2008 and moved to a Damascus suburb where he lived in a tent with his wife and children. Photo: Adel Samara, 2009.

Mzeirieb, Dar'a Governorate

Makeshift camps like the one in Hamouriyeh and larger were dotted around the Damascus suburbs and in the southern governorates of Dar'a and Suweida. Ahmed al Yehya's twenty-year-old daughter-in-law Fatima grew up in one of the forty-two "new villages" that were built in Hassakeh Governorate after the flooding of Lake Assad in 1973. Her family had received 2.5 ha of land there in compensation for the land they lost in the valley. They planted cotton and wheat, which they irrigated with groundwater. But in the early 2000s the water ran out and in 2007 the whole family moved to a camp near Mzeirieb, a village in Dar'a Governorate near the Jordanian border. There they joined hundreds of other migrants from Qamishle, Hassakeh, Deir ez-Zor, and Raqqa Governorates. There was also a small group of Sudanese. Before she was married and moved to Tel al Banat, Fatima also lived in Mzeirieb. "There was no electricity, no water, no bread in Mzeirieb – nothing," she said. "You were paid SYP 25/hr ($0.55) for working on other people's land." According to farmers in Tel al Banat, the camp had existed since the early 2000s but started attracting more migrants after the drought started in 2007.

Crammed onto a small plot of land on the edge of the village, the camp looked like a slum, with ragged tents sewn together from odd pieces of fabric and plastic (Fig. 8). The camp dwellers had developed a precarious contraption of electric wiring to tap power off a nearby pylon, a system they quickly dismantled as soon as they saw security forces coming to the camp. Conflicts regularly broke out between camp inhabitants and locals, but also among inhabitants themselves who originated from different regions and tribes. The local authorities were obviously aware of the camp on the edge of town, which was steadily growing as more migrants fled the drought in the northeast. However, camp dwellers received no government support or food assistance. Even as the impact of the drought worsened and the government launched aid appeals to the international community, all food assistance was distributed in the northeast. International and Syrian aid organizations were not granted permission to provide support to migrants, who got financial incentives from the security services (20 percent of their income in Dar'a) to return to the northeast (De Châtel 2014).

Qartaba, Mount Lebanon Governorate, Lebanon

As water ran out across northeastern Syria from the late 1990s onwards, many men and young boys also left their families in Idlib, Hassakeh, Qamishle, Raqqa, and Deir ez-Zor Governorates to seek work in Lebanon. While this form of temporary or circular migration between Syria and Lebanon has existed for decades, water scarcity and lack of job opportunities in Syria's northeast led to an increase in the late 1990s. The decision to migrate to Lebanon was spurred by the abolition of visa procedures between the two countries after the end of the Lebanese civil war in 1990, easing transit between the two countries. No official figures exist for Syrian workers in Lebanon, but estimates range between 300,000 and 500,000 during the post-war period from 1990 to 2005, representing 10-15 percent of the overall Syrian labor force (Di Bartolomeo et al. 2012).

FIGURE 7

After the flooding of Lake Tishreen in 1999, groups of migrants from the northeast lived in makeshift tents in a Damascus suburb. Photo: Adel Samara, 2009.

FIGURE 8

The tent camp near the Syrian town of Mzeirieb on the Jordanian border attracted migrants from across northeastern Syria from the early 2000s. Photo: Adel Samara, 2009.

Ahmed al Yehya's nephew, Ahmed, 28, had also made the move to Lebanon in 2005 and lived in the disused concrete shell of a half-finished building in the mountain village of Qartaba above Jbeil. For a $20 monthly rent, he shared a narrow, windowless space on the ground floor – probably intended as a storage space in the building's garage – with fifteen other men, mostly from the village of Daife near Tel al Banat. There was no hot water and no heating, which was particularly difficult during the winter months when temperatures can drop below zero and the village, which lies at an altitude of 1,250 m, can get snowed in (Fig. 9). But they were better off than the Syrians across the road, who had built tents from plastic sheeting in an unfinished parking garage and were fully exposed to the elements.

Ahmed was a relative newcomer compared to Hassan and Abdul Mustafa who had been working in Lebanon for twelve and nine years respectively. Since then, the situation back in Daife, where their wives, children and extended family still lived, had only gotten worse. "They can't irrigate anymore," Hassan said. "There is no water. There is nothing. In the 1980s life was good in the Jezira, there was water, but now there is drought and the price of diesel has gone up from $30 to $100 per barrel. It's impossible to keep farming. Even if you have land these days, you can't work on it. The land has given us nothing since the 1980s – it's fit for the rubbish… If I had had an education, I wouldn't be here. It is the same for our children. All we can do is bring them here to Lebanon and put them to work on a building site."

Bir Hassan, Beirut, Lebanon

In 2009, the Beirut suburbs were teeming with Syrian migrants. There was even a corner of Bir Hassan, near the Palestinian refugee camp of Burj al Barajneh, where you only saw Syrian license plates.

In 2009, Adnan al-Sahn, a thirty-two-year-old bricklayer, had been living in Beirut for six years. He left his hometown on the Khabur River in Hassakeh Governorate following the construction of the Bassel Dam in 1999. "As soon as they built the dam, the river's level dropped, but we tried to continue farming our land," he said. "We started using a drip irrigation system, but soon there was no water at all anymore, and we were forbidden from taking the water from the dam reservoir for irrigation. Before, we irrigated most of our land with water from the river; some of it was rainfed. But if there is no rain, then there is no way to sustain rainfed land either. Over the last ten years, water levels have constantly decreased. And now with the price of diesel going up, there is no point at all anymore in practicing agriculture. Everyone is leaving for Dar'a, Aleppo, Damascus and Lebanon…"

It was quite a change from the 1990s when Hassakeh Governorate was known as Al Khaleej Al Thaniy or the Second Gulf region for the wealth and prosperity of its local population. "We used to have employees working for us, now we have to work for others. We have had to abandon our homes and we have lost our dignity," said Adnan who lived in a disused shed behind a tall apartment block between the south Beirut suburbs of Burj al-Barajneh and Bir Hassan, a space he shared with eight others. They all used to work as farmers and shepherds because "that's the kind of work you do if you are from Hassakeh", according to Adnan who, like his seven brothers, did not finish primary school. "The situation in Syria is bad and it's getting worse. In the days of Hafez al-Assad it wasn't like this. Farmers were better off than civil servants. Now civil servants get paid more for doing nothing. We live in terrible conditions: we earn low wages, we eat bad food… Look at me: I'm thirty-two and I'm not even married yet – I've been working for ten years. And for what? What happens after this? Another ten years of this?"

FIGURE 9

Syrian migrant workers shared a small space behind the garage of half-finished residential block in Qartaba, Lebanon. Photo: Adel Samara, 2009.

CONCLUSION

Years of land and water mismanagement, growing water deficits, the dismantling of the state subsidies and the growing disenfranchisement in rural areas spurred the outbreak of the first protests against the government of Bashar al-Assad in March 2011 (de Châtel 2014). Starting in the agricultural area around Dar'a in southern Syria, the protests spread to other rural areas such as Homs, Hama, but also the suburbs of Damascus where many migrant workers from the Jezira had settled. The initially peaceful protests, which demanded freedom, dignity and an end to corruption, soon made way for armed conflict and escalating violence across the country. Now, after more than three years, the human, economic and environmental cost of war can hardly be measured. The country has been physically, economically and socially destroyed: more than 190,000 people have died (Nebehay 2014), more than a one third of the population is displaced inside and outside the country, and the economy is shattered. There is no end in sight to the conflict and no clear prospect of what the Syria of the future will look like. However, when reconstruction begins it will be crucial to emphasize the importance of a sustainable and sound natural resource management system that can provide sufficient fresh water to a growing population. The experience of the last fifty years shows that disregarding the balance of ecosystems and exploiting natural resources beyond their sustainable limit comes at a high cost. Without a reliable and safe supply of fresh water and a policy that includes sound water management and sustainable agricultural practices, it will be impossible to rebuild a stable country.

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ENDNOTES

1. Exchange rate 2005 cited in Elhadj (2005) $1 = SYP (Syrian pound) 50.
2. For example, in 2004, 38.6 percent of the population of Raqqa Governorate was illiterate according to a census by the Central Bureau of Statistics in Syria.
3. Syria's northeastern region is usually defined as encompassing the governorates of Deir ez-Zor, Hassakeh, Raqqa, and Qamishli. However, UNDP (2005) defines northeastern Syria as including Idlib, Aleppo, Raqqa, Deir ez-Zor, and Hassakeh.
4. 'Jezira' means island in Arabic and refers to the region situated between the Tigris and the Euphrates.
5. With a length of 661 km in Syria, the Euphrates is the country's most important water resource, providing an annual average of 5,574 million cubic meters of water, which represents more than 40 percent of the country's water resources (GTZ & SPC, 2009).
6. This was the "Arab belt", a 280 km-long and 10-15 km-wide band of arable land along the Turkish border, that the government outlined in the 1960s as part of a plan to "Arabize" this predominantly Kurdish region.
7. Approximate 2000 exchange rate: $1 = SYP 45.
8. Approximate 1975 exchange rate $1 = SYP 4 (Hinnebusch, 1989).

This was a merchant who sold pills that had been invented to quench thirst. “You need only swallow one pill a week, and you would feel no need of anything to drink.”

“Why are you selling those?” asked the little prince.

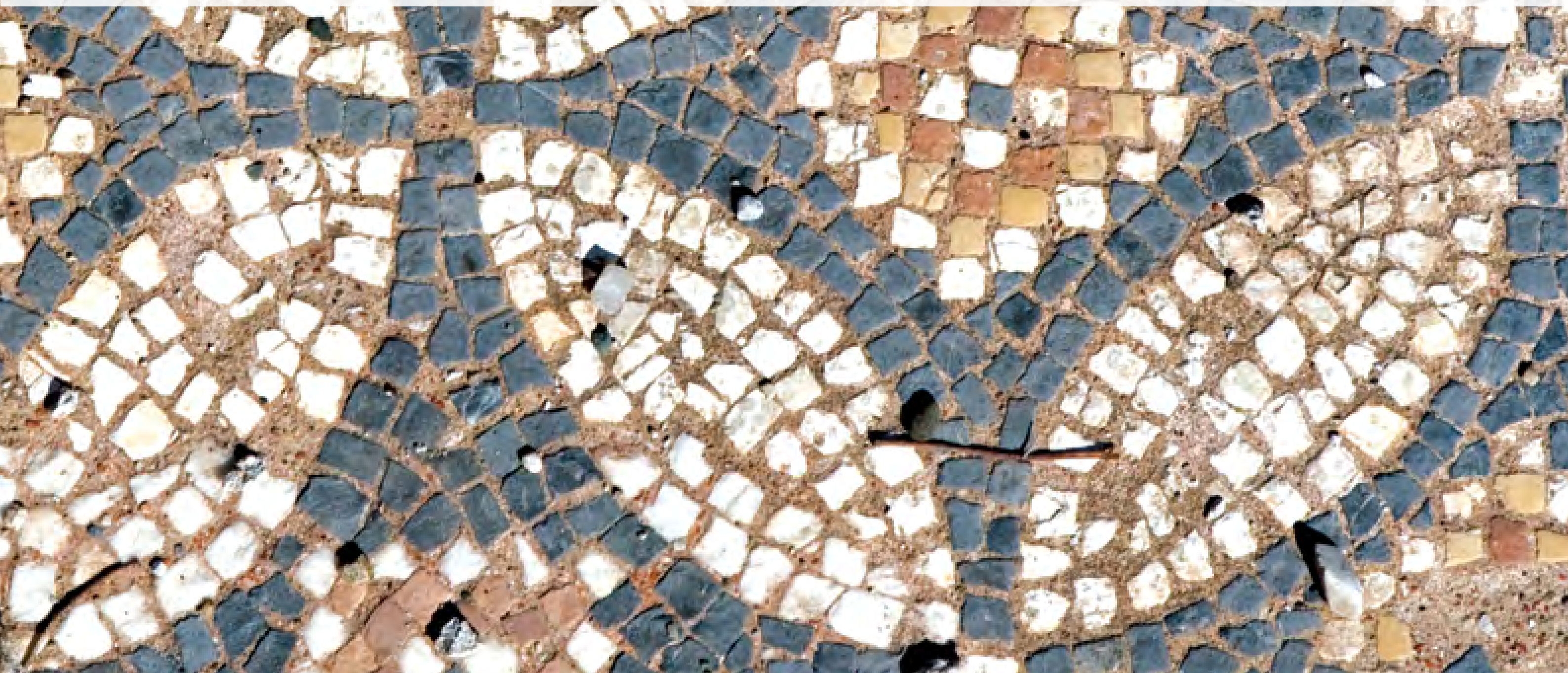
“Because they save a tremendous amount of time,” said the merchant. “Computations have been made by experts. With these pills, you save fifty-three minutes in every week.”

“And what do I do with those fifty-three minutes?”

“Anything you like...”

“As for me,” said the little prince to himself, “if I had fifty-three minutes to spend as I liked, I should walk at my leisure toward a spring of fresh water.”

ANTOINE DE SAINT-EXUPÉRY, THE LITTLE PRINCE, 1943



10. Desert Aquifers and the Mediterranean Sea:

Water Scarcity, Security, and Migration

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FIGURE 1

The Spanish coastguard intercepts a traditional fishing boat carrying African migrants off the island of Tenerife in the Canaries. Photo: UNHCR, A. Rodriguez, 2007.

Abstract

This article examines the link between water scarcity and ecological degradation, political conflict and South-North migration through the Mediterranean Basin to the European Union. The Sahelian hinterland that borders the Southern Mediterranean Basin is of particular interest as a focal point for water scarcity and ecological degradation, conflict, and emigration. The article explores the relationship between ecological degradation, whether through climatic phenomena or population pressure, and conflict in the Sahel and Eastern Mediterranean. Finally, it discusses the role of legal regulation in mitigating the effects of ecological degradation.

KEYWORDS: MIGRATION, ENVIRONMENTAL DEGRADATION, THE SAHEL, E.U. IMMIGRATION, WATER MANAGEMENT AND LAW, SECURITY

INTRODUCTION

U.S. President Barack Obama stated during a speech in Berlin in June 2013 that climate change would produce "new waves of refugees". Immigration into the European Union (E.U.) via the Mediterranean is a topical issue that is a constant feature in the media and within political circles (Fig. 1). Thirty thousand migrants crossed the Mediterranean from Africa to southern Italy in 2013, with the number of casualties estimated in the hundreds. The alarming number of casualties among migrants attempting to cross into the E.U. through its Mediterranean member states has raised global interest in the issue. The term "fortress Europe" (Carr 2012) has emerged as a result of strong E.U. policies to stem the flow of unregulated immigration and to secure Europe's borders. No region is more affected by illegal immigration than the E.U.'s Mediterranean member states: Cyprus, France, Greece, Italy, Malta and Spain, which represent a case in point of international South-North migration. Beyond the adage that immigrants flee poverty to enjoy the economic fruits of high-income states lies a complex web of factors that underpin migration trends and affect the international security paradigm. Water is the only resource that unites people across regions due to its indispensable qualities. Management of scarce water resources, not in the Mediterranean Basin itself, but in adjacent regions would address some of the issues that motivate South-North migration through the Mediterranean.

This article seeks to shed light on the ecological factors that affect South-North migration through the Mediterranean Basin and suggests that water scarcity and ecological degradation result in and contribute to conflict, which exacerbates South-North migration. The first section sets out the geographical scope of the regions discussed in the article. The second section examines water scarcity and ecological degradation in Africa's Sahel region, a hinterland of the Southern Mediterranean region, and suggests that this contributes to regional conflict, instability and South-North migration into the E.U. through its Mediterranean member states. The third section outlines the security dimensions of migration into the E.U. through the Mediterranean Basin. The fourth section suggests that cooperation in the domain of legal regulation and management of land and water through international environmental agreements can contribute to a rational use of scarce water resources, mitigating ecological degradation and improving interregional security between the Mediterranean Basin and its peripheral regions.

DISTINCT YET OVERLAPPING REGIONS AND CHALLENGES

THE SAHEL REGION

- Covers 3 million km^2
- Stretches from the Atlantic Ocean to the Red Sea
- Extends to 1,000 km at its widest
- Covers the territory of twelve countries: Algeria, Burkina Faso, Cameroon, Chad, Eritrea, Mali, Mauritania, Niger, Nigeria, Senegal, South Sudan and Sudan
- Experiences recurring droughts, the last of which began in 2010
- Civil and regional conflicts: Chad-Libya 1978-1987, Chadian Civil War 2005-2010, Northern Mali Conflict 2012-2013, Darfur Conflict 2003-present
- Suffers from accelerated desertification due to the windswept encroachment of the Sahara Desert as well as overgrazing and demographic pressure

This article examines problems that have pronounced and interconnected transboundary impacts, namely regional water scarcity, its associated ecological degradation, and migration. The genesis of the problem occurs in one region and its effects are felt in another. The phenomena occur over a number of adjacent regional belts: the Sahel, the Sahara Desert, the Maghreb and Arab southern Mediterranean states, and E.U. states in the Mediterranean region: Cyprus, France, Greece, Italy, Malta, and Spain.

The Sahel is an environmentally stressed climatic belt at the fringes of the Sahara Desert which receives limited and cyclically irregular amounts of annual rainfall. Geoclimatically, the Sahel stretches across the breadth of Africa from the Atlantic coast in the west to the Red Sea coast in the east. Geopolitically, the Sahel can be divided into three regions: West Africa, East Africa, and North Africa. In West Africa, the Permanent Interstates Committee for Drought Control in the Sahel was formed in 1973 and is comprised of thirteen West African states, in addition to Cape Verde and Chad. The mandate of the Permanent Interstates Committee for Drought Control in the Sahel is to conduct research on food security and the mitigation of the effects of desertification. In East Africa, the Intergovernmental Authority on Drought and Desertification was established in 1986 to provide a regional platform for combating environmental degradation and drought and to foster development. The authority was renamed the Intergovernmental Authority on Development in 1996 and comprises Djibouti, Eritrea, Ethiopia, Kenya, Somalia, South Sudan, Sudan, and Uganda. The most recent regional institution in the Sahel is the Community of Sahel-Saharan States, which was established as a trade bloc in 1998 at the behest of ousted Libyan leader Muammar Qadhafi. Headquartered in Tripoli, Libya, the Community of Sahel-Saharan States comprises twenty-eight member states from across West, East, and North Africa, as well as African island states. States in the Sahel have a large population in relation to the renewable water resources available in the region, with a net population of approximately 366 million and demographic growth rates ranging from 1.83 percent to 4.23 percent (CIA 2014). The Sahel has been the scene of a recent drought and a number of national conflicts that have had regional repercussions and warranted an international response. Armed conflict in the Sahel has resulted in large numbers of people migrating northwards to North Africa and across the Mediterranean into the E.U.

The great expanse of the Sahara Desert forms a natural impenetrable barrier for both human and animal habitation. However, migrants are often forced to cross the desert at great risk in order to reach North Africa and the Mediterranean coast.

The North African coastal states – Algeria, Egypt, Libya, Morocco, and Tunisia – have a history of emigration and immigration to and from Europe that goes back to colonial times. These countries continue to form a natural transit point for migrants who enter Europe via the Mediterranean. However, these North African countries are also end destinations for many refugees from the Sahel and other parts of Africa. Thirty-one thousand asylum seekers were registered with the United Nations High Commissioner for Refugees (UNHCR) in the North African sub-region in mid-2013, a sharp rise compared to less than 5,000 registered asylum seekers in 2008 (UNHCR 2013b and 2008).[1] Due to their geographical location as the Mediterranean gateway to the E.U., Cyprus, France, Greece, Italy, Malta, and Spain bear the brunt of illegal maritime immigration from the Sahel.

WATER, THE INDISPENSIBLE RESOURCE

Water is a unique natural resource in that it is essential to the sustenance of human and animal life and ecosystems. The management of scarce water resources against the backdrop of demographic growth and climate change represents one of the key challenges for development in the Sahel.

The ethical worth of water is reflected in many of the world's spiritual and religious philosophies (Chamberlain 2007). Water conforms to the definition of a "public good" which is defined as "goods that are consumed collectively… for which there is no meaningful distinction between individual and total consumption" (Eatwell et al. 1987: 1061). Recently, the indispensable nature of water to human life as a basic human right has been affirmed in the reinterpretation of rights emanating from the 1948 Universal Declaration of Human Rights. It is recognized as a resource which is fundamental to the attainment of other human rights, including the following rights which are implicitly recognized in the International Human Rights Instruments: the right to clean drinking water, the right to water for sanitation, rights recognizing and safeguarding the cultural uses of water, the right to water for agriculturalists and the right to food, as water is used to grow food (CESCR 2003).

Concurrent with the sustenance-based and public nature of water as a good, water also has great value-added economic benefit when used in a number of industries and sectors. Water has accordingly also been defined as an "economic good" according to principle 4 of the Dublin Statement on Water and Sustainable Development (ICWE 1992). The United Nations Economic Commission for Europe Charter on Groundwater Management 1989 refers to water as "a natural resource with economic and ecological value" (UNECE 1989: art. 2).

The economic value of water is manifested in its competing uses in the industrial, touristic and agricultural sectors. Although there is no global market for water, water is embedded or "virtual" in a number of globally traded industrial and agricultural goods. The economic value of water can be understood in the concept of virtual water, which seeks to quantify the amount of water that is needed to produce a commodity or product. The imbalance in water scarcity across the world reflects a global trade in virtual water, whereby in an ideal situation, states suffering from water scarcity would import goods whose production necessitates large amounts of water and export goods that do not require large amounts of water production.

WATER SCARCITY, ECOLOGICAL DEGRADATION AND CONFLICT

The Sahel region is water stressed and relies on groundwater, which is at its most vulnerable during periods of drought. Drought in the Sahel occurs cyclically over a number of years, with significant periods of drought during the early twentieth century and the 1970s. This prompted United Nations (U.N.) to organize the Conference on Desertification in 1977. The most recent regional droughts include the East African drought of 2012 and the drought in the Sahel in 2010, the effects of which are still tangible (Fig. 2). While drought is a natural phenomenon that is manifested in a lack of or minimal rainfall, its negative effects are compounded by the continued use of land, vegetation and water resources. Drought negatively impacts agricultural productivity and by extension food security. Increased pressure from high population growth and drought lead to a more intensive use of natural resources, resulting in their degradation, which in turn leads to desertification. Migration occurs through a number of stages as a consequence of drought, ecological degradation and conflict. Migration primarily takes place from drought-affected areas to rural areas that are less severely affected, and then to urban centers within the affected countries, from where it is easier for migrants to travel to the "Economic North." Drought therefore has a negative effect on productivity, socioeconomic well-being, and the macro-economy and is hence a key contributing factor to civil conflict. While individuals and communities in the Sahel region have historically used regional, cyclical South-South migration to escape ecological problems such as drought, floods, and locust infestations, migration further north, particularly of men between the ages of twenty and thirty who are fleeing war-torn communities and political persecution is a growing trend.

U.N. Secretary General Ban Ki-Moon identified the East African drought and famine as a threat to global security that necessitates collective action. Skirmishes between pastoralists and farmers have historically occurred in the Sahel and in particular in the Darfur region of Sudan during periods of drought when livestock encroached onto agricultural land due to the scarcity of pasture. Ban wrote in a 2007 *Washington Post* op-ed that climate change was one of the factors driving instability and civil conflict in the Darfur region since the early 1980s (Ban 2007). The Doha Document for Peace in Darfur addresses water management as a key component of peace and development in the region (DDFPD 2011). While they are mainly of a localized nature, civil conflicts and environmental degradation in the Sahel have had extra-regional consequences. The civil conflicts in Darfur, Mali, and the Central African Republic have all resulted in the deployment of international peacekeeping forces in the area.

FIGURE 2

A kilometer outside the village of Waridaad in Somaliland, carcasses of dead sheep and goats stretch across the landscape. Photo: Oxfam East Africa, 2011.

FIGURE 3

The Italian coastguard rescues two of the 156 survivors of the tragedy off Lampedusa that took place on 3 October 2013. Lampedusa, the closest Italian island to Africa, has become a destination for tens of thousands of refugees seeking to reach Western Europe. Photo: Guardia Costiera, 2013.

SOUTH-NORTH MIGRATION IN THE MEDITERRANEAN BASIN

The Mediterranean Basin's position as a bridge between Africa and Europe is one of its most enduring historical features. Throughout history armies, traded goods and cultures have crisscrossed the Middle Sea and enriched human history.

However, today a tragic contemporary trend has taken root in the Mediterranean, namely the clandestine transport of African migrants into the E.U. The latest World Migration Report lists economic South to economic North migration, as occurs in the Mediterranean Basin, as the predominant form of international migration (IOM 2013). Migrants risk their lives crossing the Sahara Desert to reach North Africa and the Southern Mediterranean coast as a transit point from where they can make their way to the E.U. Transit migration to North Africa from the Sahel has been recognized as a phenomenon that is likely to continue and increase, regardless of economic growth in North Africa (IMI 2006). According to UNHCR, one of the challenges that migrants in North Africa face is the lack of legislation that governs refugee status and asylum (UNHCR 2013a). In North Africa, migrants are often made hostage to gangs who demand large sums of money to take them across the sea, and are held in bondage and abused physically and sexually until full payment has been received. After this harrowing ordeal, migrants risk their lives once more, this time at sea, on boats that often capsize, killing many of those on board (UN 2010). Boat disasters off the Italian and more recently the Maltese coast have drawn attention to the plight of boat migrants (Fig. 3).

Specialist organizations such as FRONTEX, the E.U.'s agency for external border security, have identified three Mediterranean migration routes into the E.U.: a Western Mediterranean route from the Maghreb to Spain including the Canary Islands, a Central Mediterranean route from Libya to Sicily, which is the route that many migrants from the Sahel take, and a route from the Libyan coast to the region of Apulia in Italy and Cantabria in Spain (Fig 4).

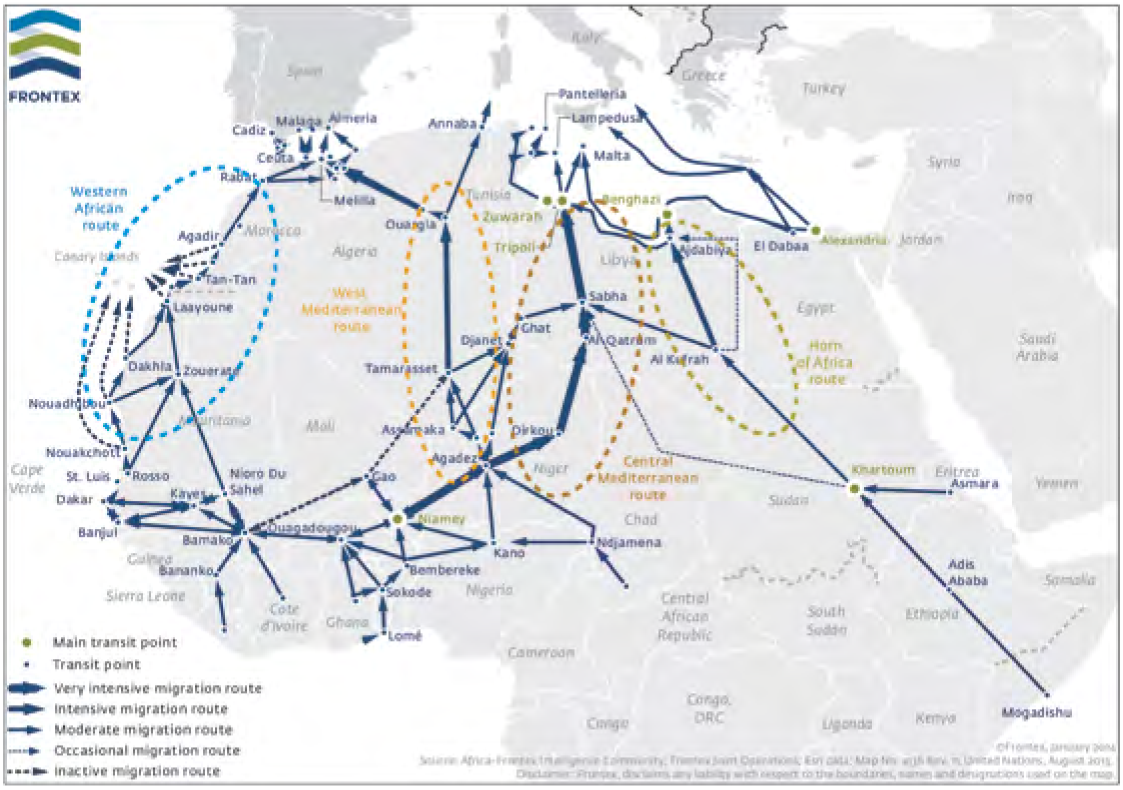
Migrants and refugees also face problems in transit countries. An illustration is the case of the Sudanese refugees, who were brutalized by the Egyptian police during their forced eviction from a public garden in front of the UNHCR building in Cairo in December 2005, resulting in twenty-nine casualties. These Darfurian and southern Sudanese refugees were internally displaced in their home country, having fled conflict in their native regions. They then made their way to Egypt as a transit point for emigration to the Economic North, including E.U. states. Another example of such abuse is the case of sub-Saharan African guest workers who had sought work in Libya with the encouragement of the Qadhafi regime, but were then associated with mercenary groups loyal to Qadhafi after the fall of his regime in February 2011 and forced to flee to neighboring Tunisia. (AJE 2011).

Immigration into the E.U. is by no means an exclusively sub-Saharan African occurrence. The unrest following the Arab Spring has resulted in large numbers of Tunisians and Libyans crossing the Mediterranean into Italy. The civil war in Syria has similarly resulted in large numbers of Syrians attempting to cross from the Eastern Mediterranean into Italy and Greece. Syrian refugees are also present in North Africa, with 127,000 registered refugees in Egypt in 2013 (UNHCR 2013b). Here too, cases of mistreatment have been reported. Once in E.U. territory, migrants face harsh challenges, and UNHCR has criticized the migrant detention centers on the Italian island of Lampedusa for their inadequacy.

The global financial crisis has hit hard in the E.U., driving up unemployment rates and spurring austerity measures in member states. In this context, the arrival of migrants from sub-Saharan and North Africa has heightened concerns over the perceived threat of large-scale immigration (Carter 2013). Immigration is indeed problematic, both for the migrants who are exploited and abused, and who risk their lives; and for host communities who lack the capacity to integrate migrants into their economies. Politically, E.U. member states view immigration either as an issue of high strategic importance or as an issue of national security. The humanitarian view of migration has been subsumed by the view that migration is a threat, with negative quantitative and qualitative effects on national budgets and expenditure, the national labor force, and demographic and cultural cohesion. This is evidenced by the rise and success of the parochial ethos of xenophobic, anti-immigrant, far-right parties in France, Italy, and Greece, whose political platform is fixated on combating immigration, a philosophy that runs contrary to the Mediterranean Basin's role in human history as a cradle of world civilizations and cultures.

Whilst united in xenophobia against immigration, the most prominent far-right parties in the Euro-Mediterranean region do not have substantive policy positions on international environmental conventions and global ecological issues such as environmental degradation due to increased population pressure, climate change, and environmental security. Parochial, reactionary perspectives will not address common global problems such as ecological degradation that are transregional and that necessitate collective action. Nor will these perspectives contribute to the mitigation of its negative consequences.

FIGURE 4



Map of key migrant routes from Africa to Europe in 2007. Source: Frontex, 2014.

INTERNATIONAL ENVIRONMENTAL LAW AND WATER MANAGEMENT IN DRYLANDS

As Bilder (1980: 385) states: "International law provides a process, a set of techniques and a body of experience which can help nations to forge better solutions to resource problems; the only tools available for cooperative efforts are those provided by international law." The merits of international law for the management of groundwater resources have been described by Stephan (2007: 148) as follows: "International law plays a significant role in facilitating the quality of ...[the governance, science and society] interfaces by codifying norms and values to the extent that these can become building blocks of future cooperation."

The 1996 United Nations Convention on Combating Desertification (UNCCD) is the final product of global deliberations over the problem of desertification that began in 1977. The impetus for a global convention on combating desertification was given at the United Nations Conference on the Environment in Rio de Janeiro in 1992 and was specifically set out in the conference's action plan, Agenda 21. The convention is exceptional in the extent of its global membership, which includes all E.U. member states. The UNCCD was drafted with the global consequences of desertification in mind; it is an inclusive convention that brings together states affected by desertification, as well as states that are not affected by the problem in their capacity to offer technical and financial support. Affected states are obligated to formulate national action plans and long-term strategies for the combating of desertification. The obligations of developed countries, such as the Euro-Mediterranean states, are set out in article 6 of the general provisions of the UNCCD and include the obligation to: "promote and facilitate access by affected... developing country Parties, to appropriate technology, knowledge and know-how" (UNCCD 1996).

The UNCCD takes a holistic and interdisciplinary view of desertification's consequences, as illustrated by article 4 of the UNCCD, which obliges parties to: "give due attention, within... relevant international and regional bodies, to the situation of affected developing country Parties with regard to international trade, marketing arrangements and debt with a view to establishing an enabling international economic environment conducive to the promotion of sustainable development", and "strengthen sub-regional, regional and international cooperation" (Ibid.).

E.U. states continue to be active in the International Law Commission of the United Nations, which adopted the recent Draft Articles for Transboundary Aquifers in 2009. One of the miscellaneous provisions of the Draft Articles (article 16) is entitled "Technical cooperation with developing States" and obligates states to

> directly or through competent international organizations, promote scientific, educational, technical, legal and other cooperation with developing States for the protection and management of transboundary aquifers or aquifer systems, including, inter alia: (a) Strengthening their capacity-building in scientific, technical and legal fields; (b) Facilitating their participation in relevant international programmes; (c) Supplying them with necessary equipment and facilities; (d) Enhancing their capacity to manufacture such equipment;(e) Providing advice on and developing facilities for research, monitoring, educational and other programmes; (f) Providing advice on and developing facilities for minimizing the detrimental effects of major activities affecting their transboundary aquifer or aquifer system; (g) Providing advice in the preparation of environmental impact assessments; (h) Supporting the exchange of technical knowledge and experience among developing States with a view to strengthening cooperation among them in managing the transboundary aquifer or aquifer system (Stephan 2009: 22).

The provisions of the Draft Articles for Transboundary Aquifers should be put into effect for the governance of the water in the transboundary aquifers and transboundary aquifer systems of the Sahel and Saharan region such as the Tindouf Aquifer between Morocco and Algeria, which stretches across 210,000 km^2; the Northwest Sahara Aquifer System between Algeria, Libya, and Tunisia, which covers over 1 million km^2; the Mourzouk-Djado Basin between Chad, Libya, and Niger, which covers 450,000 km^2; the Nubian Sandstone Aquifer System between Chad, Libya, Egypt, and Sudan, which covers nearly 2.2 million km^2; the Tin-Serinine Basin

Parochial attitudes will not address global problems such as ecological degradation.

between Algeria and Niger; and the Air Crystalline between Algeria, Mali, and Niger. The presence of large amounts of fossil water in the Sahel and Sahara Deserts provides evidence of historical climate change. The vast quantity of water in these desert aquifer systems is rainfall stored many thousands of years ago when what is now the world's largest hot desert was a verdant region with a tropical climate. A legal methodology that is based on scientific data and put into effect by a legal framework is needed in order to govern the precious groundwater in the aquifers and aquifer systems of the Sahel and Sahara, and Euro-Mediterranean countries can make significant contributions in this endeavor.

The E.U. and its institutions are a legal model of excellence in supranationalism and the rule of law. Taking into account their growing presence in the international arena, the E.U. Mediterranean states and E.U. institutions can play a leading role in improving water and land management conditions in the Sahel. Euro-Mediterranean states can embrace and promote the use of international environmental law to regulate and rationally manage scarce water resources and to mitigate the impact of increased population, ecological degradation and climate change, in line with their commitments as member state parties to the UNCCD.

CONCLUSION

This article has examined the issue of South-North migration through the Mediterranean Basin from an ecological viewpoint, by investigating the link between the environmental scarcity of water, civil and regional conflict in the Sahel, and the constant flow of migrants from the area into the European states of the Mediterranean Basin. It was found that regional displacement in the Sahel is linked to ecological degradation and that E.U. member states view South-North immigration in the Mediterranean Basin as an issue of national security. A desirable outcome would be for the amalgamation of national security goals with pan-regional environmental challenges and their consolidation within international water law frameworks in order to foster development in its widest sense and mitigate the consequences of decreased water availability.

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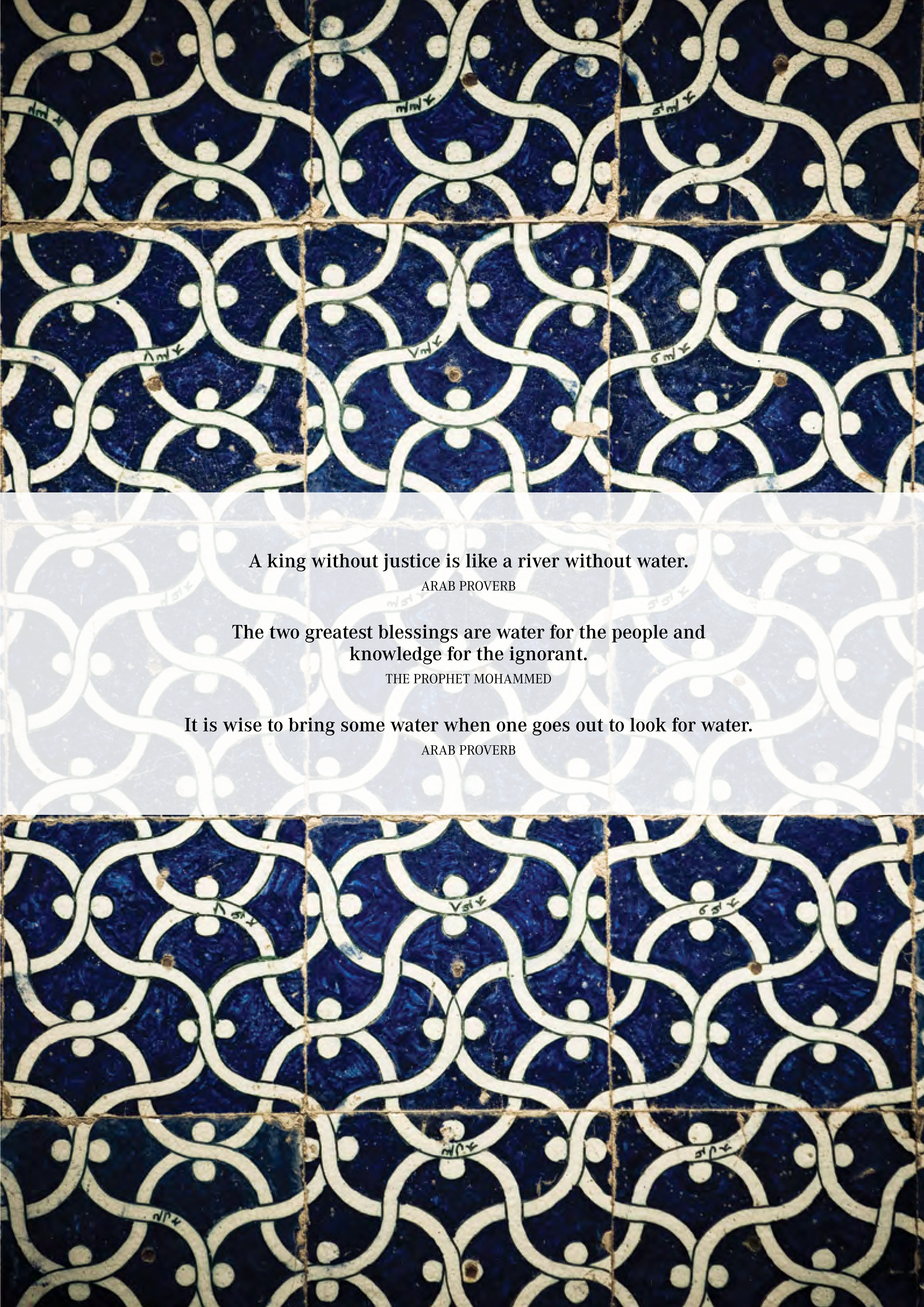
ENDNOTES

1. It is important to point out, however, that this sharp increase is also partly due to the political unrest and conflict in North Africa and the Middle East, with tens of thousands of Syrians fleeing to Egypt, Algeria, and Morocco.



A king without justice is like a river without water.

ARAB PROVERB

The two greatest blessings are water for the people and knowledge for the ignorant.

THE PROPHET MOHAMMED

It is wise to bring some water when one goes out to look for water.

ARAB PROVERB

11. The Preservation of Foggaras in Algeria's Adrar Province

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Abstract

The foggara is an ingenious traditional technique of groundwater exploitation used to supply domestic and agricultural water to communities in arid areas. In Algeria's Adrar Province, foggaras have for centuries provided a sustainable supply of water and played an important role in sustaining the livelihoods of local populations in a hyper-arid environment. In order to preserve this important source of water that can also be considered a piece of national heritage, Algeria's National Agency of Hydraulic Resources has started inventorying the region's foggaras, and collecting information about their state, location, and productivity into a GIS database.

KEYWORDS: FOGGARAS, ADRAR PROVINCE, ALGERIA, GIS MAPPING, TRADITIONAL IRRIGATION SYSTEMS

FIGURE 1

View of the underground gallery of an Adrar foggara. Photo: Taha Ansari, 2011.

INTRODUCTION

The Sahara is the third-largest and hottest desert in the world. Water is scarce in this hyper-arid region, with annual precipitation rates of less than 100 mm and as little as 20 mm in some places. Surface water in the form of small seasonal streams is rare and populations rely on non-renewable fossil groundwater reserves. Through history, the population of the Sahara has adapted to the arid conditions, migrating to less arid regions in times of extreme drought and adapting their lifestyle to water-scarce conditions by developing sophisticated ways of exploiting local groundwater reserves.

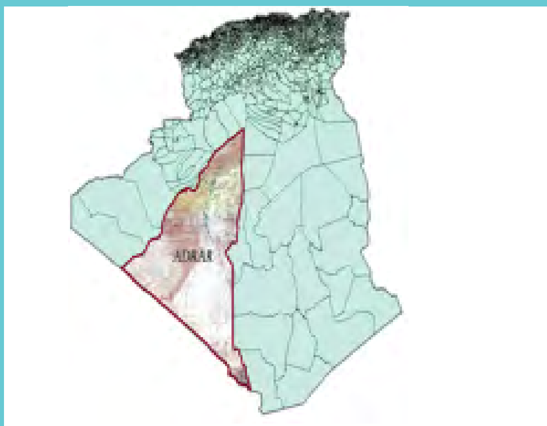
One of the techniques used in the Algerian Sahara is the foggara, a groundwater collection and distribution technique that relies on a network of wells and tunnels. Historically, the development of foggaras in the Algerian Sahara allowed for irrigation of crops, the maintaining of palm groves, and the supply of towns and villages in an extremely arid environment. Today, the implementation of a regional water management strategy and regular maintenance and monitoring of foggaras allows for the development of sustainable forms of agriculture.

THE SAHEL REGION

- Covering an area of 427,968 km², the province of Adrar is located in the central part of the Algerian Sahara (Fig. 2)
- It is divided into four regions: Gourara, Tanezrouft (Bordj Badji El Mokhtar and Timiaouine), Taouat, and Tidikelt
- Estimated population: 433,000 inhabitants
- Water resources: Groundwater is the principal source of water as rainfall is rare. The few seasonal streams can cause sudden and violent floods.
- The region has three key geomorphological features:
  - A vast plain (plateau) with a maximum altitude of about 400 m, bounded by the Tademaït Plateau to the east and a depression to the west
  - A 5-10 km wide depression located along the western edge of the plain. This is where the palm groves are located.
  - Small sebkhas[a] on the western edge of the depression form the natural outlet of the aquifer

a) Sebkhas are depressions that contain brackish water after rainfall, but are dry and covered with salt incrustations in summer.

FIGURE 2

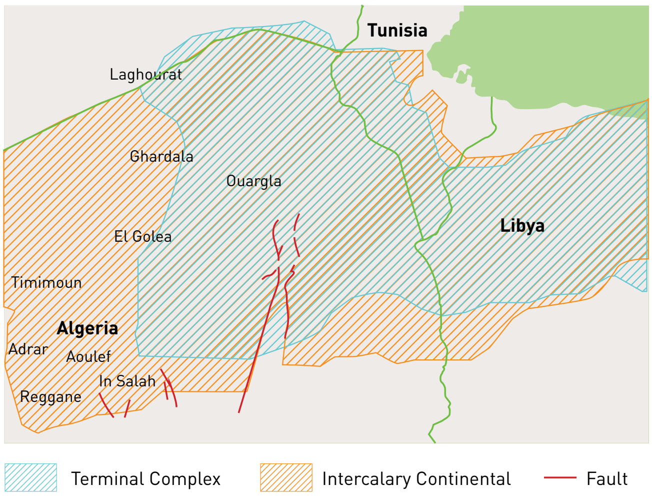


Map of Algeria showing Adrar Province. Source: Taha Ansari.

HYDROLOGY

The groundwater used in most of Adrar Province is drawn from the Northwestern Sahara Aquifer System (NWSAS), which covers a total area of over 1 million km²: 700,000 km² in Algeria, 80,000 km² in Tunisia and 250,000 km² in Libya. It is made up of two superimposed thick aquifer layers: the Intercalary Continental Formation and the Terminal Complex Formation. Populations in the Adrar region draw water from the Intercalary Continental Formation, which has a thickness of between 150 m and 450 m and a static level of between 6 m and 30 m. Water is abstracted through boreholes, wells, and foggaras (Fig. 3).

FIGURE 3



Northwestern Sahara Aquifer System. Source: Ghazal Lababidi after Besbes et al., 2007.

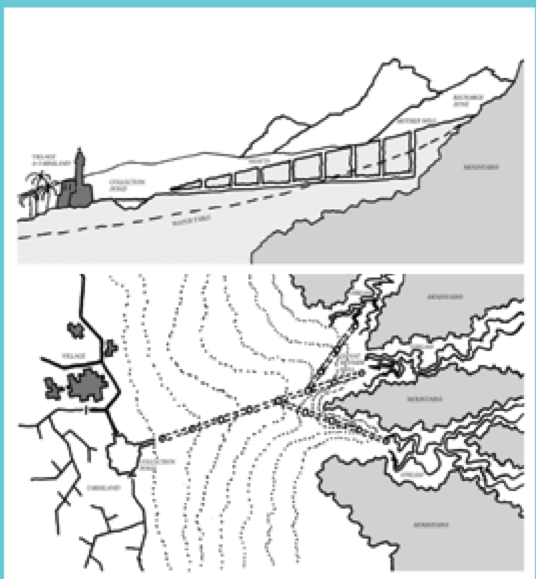
FOGGARAS IN THE ADRAR

The topographic and hydrological conditions in Adrar Province – the natural depression and the presence of shallow water – make it highly suitable for the development of foggaras. Indeed, maps of Adrar Province show that all foggaras are located in the vicinity of the Tademaït Plateau. Foggaras in Adrar bring water from the Intercalary Continental Formation to villages and palm groves. Foggaras are made up of two distinct parts: the most important "active" upstream part, which enters into the aquifer (Fig. 1 and 4); and the "inactive" downstream part, which allows the flow of water to crops and settlements. The foggara outlet, from where different smaller canals or *seguias* branch off [Fig.7], is known as the comb or *kasria* (Fig. 6).

FIGURE 4

A foggara well. Photo: Taha Ansari, 2010.

FIGURE 5



Cross-section and plan of a typical qanat. Source: De Châtel, 2007.

WHAT IS A FOGGARA?

A foggara is a network of tunnels and wells that taps groundwater and provides a reliable supply of water for human settlements and irrigation in hot arid and semi-arid climates. Also known as *qanat*, *khettara* and *falaj* in other parts of the Middle East and North Africa, the foggara remains one of the most sustainable methods of groundwater exploitation as it relies only on the natural discharge of the aquifer and therefore never taps the groundwater beyond a sustainable rate (Fig. 5).

Local communities manage the foggaras according to a traditional system that has been in use for many centuries. Most villages (*ksars*) have several foggaras, and each foggara has a name. Each foggara is managed by a user association, which is officially recognized by the Algerian state. The user association is responsible for the rehabilitation and maintenance of the foggara, but also forms the link between the inhabitants of the *ksar* and the local administration. The 707 perennial foggaras in Adrar Province irrigate 176 palm groves, which cover a total area of 113,353 ha. A variety of vegetables are cultivated here, including tomatoes, onions, potatoes, garlic, eggplant, carrots, and peas (Fig. 8).

FIGURE 6

View of a foggara outlet, known as the comb or *kasria*. Photo: Taha Ansari, 2011.

CHALLENGES TO THE FUNCTIONING OF THE FOGGARA

Despite the long history of foggaras and their use in the Algerian Sahara, they remain complex and fragile systems of water distribution that are sensitive to geological, hydrogeological and socioeconomic factors and changes:

-The flow of a foggara is always influenced by the type of geological formation from which groundwater is extracted: a foggara dug in sandstone has a higher flow rate than a foggara dug in clay.

-Foggaras in the Adrar draw water from the Intercalary Continental Formation, which has a low rate of renewability. Therefore any drawdown by pumping through boreholes directly influences the flow of the foggaras.

-The length of the inactive zone: The downstream part of the foggara is a transitional zone of variable length, connecting the active part of the foggara to the palm grove. Part of the water passing through this part of the foggara is lost to seepage and therefore the longer this section, the more water is lost.

-Proper maintenance of the foggara requires qualified manpower and appropriate materials (Fig. 9). This raises a number of questions about the future of foggaras, such as how skills and expertise can be passed on to younger generations, and how the practice of foggara rehabilitation and maintenance can be improved and modernized through the introduction of new techniques and tools, such as excavators and hoisting blocks.

INVENTORYING THE FOGGARAS

The traditional inventory

The historic scarcity of water in Adrar Province has made it a precious and valuable resource that can be inherited, sold, and bought, just like land. Such transactions are all carried out with utmost care and according to a time-honored practice, with a specialist measuring the foggara's flow rate and allocating shares of water according to a set unit of measurement. All the details of the operation and management of each foggara are collected in a register, the *ezzemam*. This traditional inventory has been used in the same way for centuries and contains key data including

FIGURE 7

A seguia, the channel that brings water to crops. Photo: Taha Ansari, 2002.

FIGURE 8

The crops in palm groves in the Adrar are irrigated by foggaras. Photo: Taha Ansari, 2002.

FIGURE 9

Traditional techniques for foggara maintenance in the Adrar. Photo: Taha Ansari, 2010.

the names of all users or shareholders, the quantity of water allocated to each user and information about the buying and selling of water. The *ezzemam* is kept and managed by a respected village elder.

A new inventory

In 1998, Algeria's National Agency of Hydraulic Resources (ANRH) inventoried all foggaras in Adrar Province. This inventory has been updated and refined since 2011 using GPS to precisely map out the location, length, and course of all foggaras with their wells and combs. To date, a total of 1,829 foggaras have been inventoried, including 707 perennial foggaras, 371 dried out and backfilled foggaras, and 751 foggaras in which water no longer flows into the comb and which only contain stagnant water in the tunnel. In addition, 149,250 wells have so far been located through GPS; 600 of these have also been measured for depth. A total of 1,690 combs were also positioned by GPS.

As part of this regional survey, water quantity and quality were also assessed in 2011: the flow rate of the perennial foggaras was measured with a mini current meter, providing crucial data with relation to the irrigated areas. In addition, samples were taken from 681 foggaras to assess physical and chemical properties of the water including pH, salinity (Total Dissolved Solids), Sodium Adsorption Ratio, and calcium and magnesium concentration. Overall, the water quality tests showed that 85 percent of the water in the foggaras in Adrar Province is suitable for irrigation purposes.

FIGURE 10 a

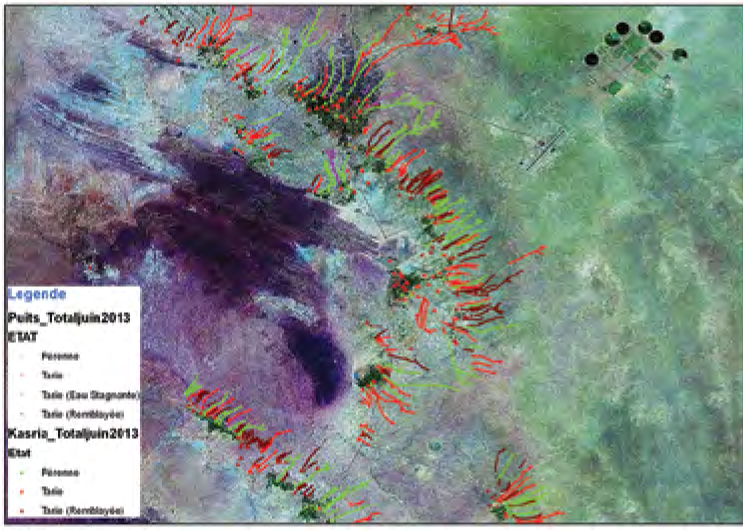
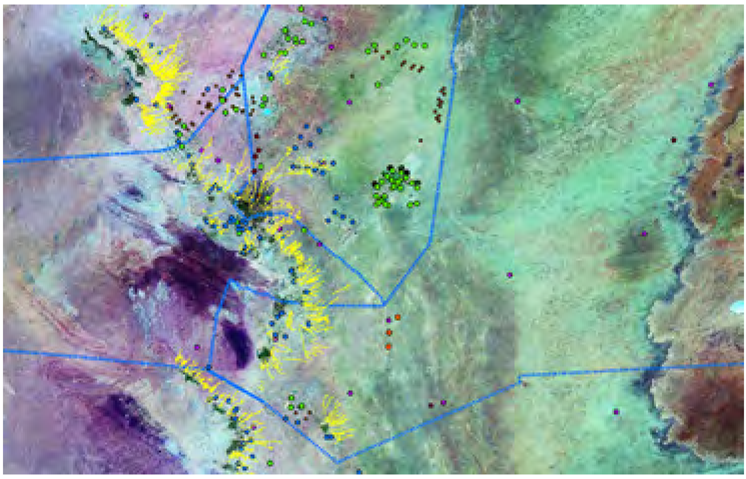


FIGURE 10 b



The GIS database has allowed for the mapping of wells, foggaras and boreholes in the Adrar, and the monitoring of water levels and quality in the foggaras. Source: Taha Ansari, 2013.

The creation of a GIS database

The collected data forms a valuable tool for improving the management of foggaras in Adrar Province. Moreover, data digitization has provided new insights into the functioning of foggara systems and allows for the development of different scenarios to improve future management. All the collected data (number, depth, and location of wells, number and location of combs, flow rate, water quality parameters) were introduced into a Geographic Information System (GIS) database. To date, the database features 300 topographic maps, 39 geological maps, 320 digital elevation models and satellite pictures. The database allows users to study detailed information about each well, borehole or foggara (Fig. 10a and 10b). Importantly, the database will allow ongoing monitoring of the state of each foggara. By combining two maps – one showing the depth of the foggara wells (static data) and one piezometric map (fluctuating data) – one can situate the active and inactive part of each foggara and calculate its flow rate. Other benefits of the GIS database include clearer insight into data, better dating, monitoring and updating, easier access to information, and greater ease in sharing information between stakeholders, which in turn allows for the development of a joint management system and greater dialogue between stakeholders.

Protecting the foggaras

The Algerian state plays a key role in the conservation of the foggaras in Adrar Province, investing significant amounts in their rehabilitation and sound management.[1] Maintaining the foggaras is key to life in the southern oasis towns and to ensuring their sustainable development. The preservation of foggaras and their environment should be combined with a policy to limit irrigation with pumps in their vicinity as this lowers groundwater levels (Sahli 2014).

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ENDNOTES

1. The Algerian state invested around $3.4 million for the restoration of thirty-one foggaras in 2013, $5.1 million for the restoration of thirty-five foggaras in 2011, and $1.9 million for the restoration of twenty-three foggaras in 2010.

Abstract

Growing water scarcity in the Middle East and North Africa region calls for new food production strategies, as conventional approaches such as increasing crop yields, irrigation modernization and agricultural water demand management are unlikely to provide a lasting solution. Instead, agricultural development strategies in this arid region must focus on increasing water productivity to produce "more crop per drop", an approach which could double food production with available water resources in the next twenty years. Policy makers must prioritize the implementation of policies to support the necessary changes, including changing cropping patterns and irrigation management, crop improvement strategies and prioritizing food trade.

KEYWORDS: MENA, WATER SCARCITY, FOOD SECURITY, AGRICULTURE, WATER PRODUCTIVITY

12. The Need for a Paradigm Change: Agriculture in the Water-Scarce MENA Region

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FIGURE 1

Small water-harvesting reservoir for supplemental irrigation in southern Turkey. Photo: Theib Oweis, 2007.

INTRODUCTION

Water scarcity and food security

The Middle East and North Africa (MENA) region faces unprecedented levels of water scarcity and food insecurity. Food insecurity is a major concern for all countries in the region, which imported more than half of the regional demand in grain, or over 70 million tons, in 2011. Moreover, the gap between national needs and production is widening. Constraints are mainly associated with water scarcity, but also unfavorable climate and/or degraded land resources and lack of investment (Solh 2011).

Water scarcity and poor water quality form serious threats to food security and health in the MENA region.

The amount of water available for agriculture is one of the most critical factors for food security. Water scarcity and poor water quality form serious threats to food security and health. Rapid population growth since the mid-1970s has reduced per capita renewable water resources in MENA countries from an average of 2,925 cubic meter per year in 1962 to 1,179.6 cubic meter per year in 1992 and an alarming 743.5 cubic meter per year in 2011. This is below the water poverty line of 1,000 cubic meter per year and a fraction of world average per capita water availability of 7,240 cubic meter per year. Most MENA countries have a per capita availability of less than 500 cubic meter per year, the World Health Organization threshold for severe scarcity, with seven countries disposing of less than 200 cubic meter per year. By 2030, the effects of climate change will have reduced renewable water resources in the region by a further 20 percent. Moreover, droughts will be more frequent as precipitation levels further decrease and domestic and agricultural water demand grow with rising temperatures (UNDP 2013).

The MENA countries draw heavily on groundwater to meet rising demand. Overexploitation and depletion of groundwater reserves have severe environmental consequences in addition to depleting national assets. The mining of groundwater resources has resulted in rapid depletion of aquifer reserves, salinization, and deterioration in water quality. In addition, the region's groundwater reserves are threatened by pollution from agricultural, industrial, and domestic activities. A recent report on water referred to the "water crises" in the region and suggested that "[r]esolving the crisis will require enduring progress towards political, social, economic, and administrative systems that shape the use, development, and management of water resources and water delivery in a more effective, strategic, sustainable, and equitable direction" (Ibid.: iv).

About 80 percent of the region's total water resources are used to produce food. However, high population growth rates and improvements in living standards mean that more water is diverted to other priority sectors, such as domestic and industrial, leaving less water for agriculture. Ironically, as water for agriculture is declining, more food is needed and regional food security is increasingly threatened. In several countries, such as Jordan, marginal-quality water has become a major source of irrigation water (Al-Karaki 2011).

Despite its scarcity, water continues to be misused. New technologies allow farmers to extract groundwater at rates far in excess of recharge, rapidly depleting centuries-old aquifers. The productivity of water in the region is still low, but varies depending on crop and country. Water scarcity and mismanagement will also accelerate environmental degradation, through soil erosion, soil and water salinization, and waterlogging. These are global problems, but they are especially severe in dry areas (Pereira et al. 2002).

This paper will first highlight general misconceptions regarding water losses and savings associated with traditional and modern practices and methodologies currently in use. It will then introduce the water productivity framework and describe true water savings, use and benefits, and finally suggest some promising ways of developing sustainable agricultural models in a context of growing water scarcity.

NEW WATER FOR AGRICULTURE IS LIMITED

The majority of water resources in dry areas are already tapped and used for various purposes (UNDP 2013). The technical options listed below could provide additional water resources, though many obstacles need to be overcome.

- **Desalination** is a potential new source of water. However, it remains a costly option that has negative environmental impacts. Half of the world's desalinated water is produced in oil-rich countries in the MENA region. Desalination capacity has rapidly increased over the last decade because of the increase in water demand and a significant reduction in desalination costs as a result of significant technological advances. Under the most favorable conditions, the cost of desalinated seawater has fallen below $0.50 per cubic meter while in other locations the cost is near or above $1.00 per cubic meter (Ghaffour et al. 2013).

- **Brackish water** offers some promise. The region has notable amounts of brackish water, mainly in groundwater aquifers, which can either be used directly in agriculture or be desalinated at low cost for human and industrial use.

- **Treated effluent** is another important source of water for agriculture in areas of extreme scarcity, such as Jordan and Tunisia where it accounts for about 25 percent of the country's water resources. It offers many advantages as it lacks the uncertainties of surface water resources and can meet a proportional share of the rising water demand from urbanization and population growth (UNDP 2013).

- **Agricultural drainage** is becoming an attractive option. In Egypt, drainage water from agricultural lands is collected in an extensive drainage network and recycled in the system after it is mixed with fresh water downstream until it becomes too saline for productive use. Currently about 5.5 billion cubic meters of drainage water is reused in Egypt, a figure that is set to rise to about 10 billion cubic meters by 2017 (Abdel-Shafy and Mansour 2013).

- **Rainwater harvesting** represents a real recovery of otherwise lost water and provides opportunities for decentralized community-based management of water resources. In dry environments, hundreds of billions of cubic meters of rainwater are lost every year through runoff to salt sinks and evaporation from bare soil surfaces through lack of proper management and sustainable ecosystems development. The International Center for Agricultural Research in the Dry Areas (ICARDA) has demonstrated that over 50 percent of water that is otherwise lost can be captured through water harvesting and used in agriculture (Oweis et al. 2012).

- **Water transfers** between water basins and between countries have been extensively discussed in the Middle East over the last few decades. Several countries have considered importing water from other basins. Options depend on economic, political, and environmental measures. Interbasin transfers may also have significant ecological impacts on both the transferring and receiving basins that are yet to be examined.

INADEQUATE COPING STRATEGIES

The main strategies currently used to cope with water scarcity are no longer adequate or sufficiently effective. They include:

Yield increases, which require more water

The Green Revolution transformed food production by increasing grain yields severalfold through improved cultivars, better fertility, and water management. It has been widely shown that proper management of water and well-established cropping systems can generate large yield increases. However, higher crop yields generally require greater water use. While higher yields (production per unit area) reflect more efficient use of the resources, the relationship between biological yield and evapotranspiration is nearly linear (Zhang and Oweis 1999). When this relation is nonlinear, higher yields will require an even higher rate of water use, mainly because of increased evaporation associated with more irrigation and/or precipitation. It is true that the relationships of other yield components, such as grain yield, differ from that of biological yield (as other factors affect the harvest index[1]), but the relationships are generally positive. So it is still possible to increase yields with improved crop varieties, better fertility/cultivation practices, and water management, but this will also require a greater supply of water. This is not to say that there is no room for increasing a specific crop yield per unit of land without additional water, as this is possible by improving the harvest index and transpiration efficiency and suppressing evaporation. But those potential increases are rather limited and may not contribute substantially to solving the MENA region's water scarcity and food security issues.

Farmers adopt three strategies to improve water use efficiency: i) reducing evaporation from the soil surface, deep percolation and residual water in the root zone, ii) improving the crop's transpiration efficiency and iii) increasing the harvest index. The three processes are not independent, as targeting specific traits to improve one process may have detrimental effects on the other two, but there may also be positive interactions (Farquhar et al. 2004). Except for increasing transpiration efficiency, the other processes require more water to increase yields.

Drought-tolerant varieties, for example, yield better under drought conditions than water-responsive varieties, but this higher yield still requires more water. Improved varieties have, among other factors, a greater capacity to extract water from the soil profile when the soil-water level is low, or to reach deeper layers as their roots go deeper than those of normal varieties. The additional water that a drought-tolerant variety absorbs will therefore not be available for future crop use. This means that increasing yields does not necessarily save water proportionally. Ignoring residual water in the soil before and after the crop season and soil-water movements during the season often leads to underestimates of actual crop water use. We usually use more water, which is hidden and not apparent to water users, and a false impression of water saving is often attributed to the crop or to the system.

Generally, substantial increases in crop yields require larger supplies of water, which may not be available. Thus, a yield-targeting strategy alone cannot solve the water shortage problem.

Improving irrigation systems and efficiencies: the scale issue

The term "efficiency" refers to the ratio of output to input. It is widely used in irrigation system design, evaluation, and management. Irrigation application efficiency, the most important, reflects losses of water through deep percolation and runoff. Such water losses are mainly "on-paper" and not real. Deep percolation losses can largely be recovered as they normally join adjacent groundwater or springs. Runoff losses end up in downstream fields and are often used by other farmers. Drainage water can be recycled and used for more salt-tolerant crops before becoming too saline for any crop use (Van Steenbergen and Abdel Dayem 2007). Although most of these losses are recoverable, engineers strive to minimize them as their recovery implies some costs to the user and to the environment.

Irrigation efficiencies are essential for the design, monitoring, and performance evaluation of irrigation systems, but there are certain caveats. Increasing application and conveyance efficiencies saves water at the farm level, but not necessarily at the scheme or basin level, as "lost" water can be recycled and reused downstream. Moreover, higher irrigation efficiency implies better irrigation performance – but not necessarily higher agricultural production (Kijne et al. 2003).

Many countries strive to convert traditional surface irrigation to modern systems, such as drip and sprinklers, which achieve higher water application efficiency. Reducing field losses by converting to modern systems will not create substantial additional water resources. To fully understand the significance of surface irrigation system losses, they need to be considered on a larger scale in order to evaluate the real and on-paper losses across the system.

Modern systems can be efficient only if they are managed properly. Often they are no more efficient than traditional surface systems because of poor management. Some drip systems are operated at 56 percent of their capacity or less. Surface systems can perform better if designed and operated properly (Shatanawi et al. 2005). Surge flow furrow irrigation can achieve over 75 percent application efficiency (Oweis and Walker 1990). The selection of the appropriate irrigation system may not depend solely on its application efficiency, but on other physical and socioeconomic conditions at the site.

It is well established that modern irrigation systems can achieve higher crop productivity. However, this is achieved through better control, higher irrigation uniformity, reduced irrigation frequency, better fertilization, and other factors. In drip systems, real water saving can be achieved by reduction of evaporation losses. The increased land productivity, however, comes at a cost – higher capital, higher energy consumption, and more maintenance requirements. Successful conversion requires a developed industry; skilled engineers, technicians and farmers; and regular maintenance.

Modern systems are most successful in areas where water is scarce and expensive, so that farmers can recover the system cost by reducing irrigation losses and increasing productivity. When water is cheap and abundant, farmers have little incentive to convert to modern systems. In fact improving surface irrigation systems through land leveling and better control may be more appropriate for most farmers in developing countries. The vast majority of irrigation systems worldwide are surface irrigation; this is unlikely to change in the near future. A wise strategy is to invest more in improving surface irrigation, while simultaneously encouraging the use of modern systems when conditions are favorable (Oweis 2012).

Managing water demand: limited results

Although water is extremely scarce in the MENA, it is generally supplied free of charge or at a low and highly subsidized rate (Cosgrove and Rijsberman 2000). Farmers have little incentive to restrict their use of water or to spend money on new technologies to improve the use of available water. International agencies, donors, and research institutes advocate water-pricing schemes based on total operational cost recovery. Although it is widely accepted in the region that water pricing would improve efficiency and increase investment in water projects, the concept of pricing presents enormous practical, social, and political challenges.

Traditionally, water in MENA countries is considered as God's gift, to be distributed free of charge to everyone. There is additional pressure from farmers for subsidized water deliveries. There is also a fear that once water is established as a market commodity, prices will be determined by the market, leaving the poor unable to buy water even for household needs. Downstream riparian countries fear that upstream countries may use international waters as a market commodity in the negotiations on water rights.

One cannot ignore these very real concerns, especially now, as politicians in the region do not want to upset farmers after the "Arab Spring". Innovative solutions are therefore needed to place a real value on water in order to improve efficiency, but at the same time abide by cultural norms and ensure that people have sufficient water to meet their basic needs. Subsidies for poor farmers may be better provided in areas other than water, so that the subsidies do not encourage inefficiency. Countries must strengthen the recent trend to recover the operation and maintenance costs of irrigation supply systems.

Water pricing and other tools of demand management will reduce the demand for water in agriculture, but may not improve agricultural production and/or increase poor farmers' livelihoods. This will benefit other water-use sectors, but may not contribute to increasing food security.

THE PARADIGM CHANGE

From efficiency to productivity

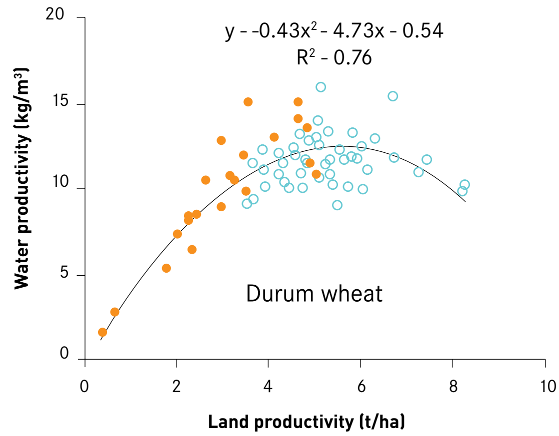
Improving irrigation efficiency, although necessary for improved performance of irrigation systems, does not reflect many aspects of agricultural water use, especially water productivity (WP), which is the return or the benefits derived from each cubic meter of water consumed. This return may be biophysical (grain, meat, milk, fish, etc.), socioeconomic (employment, income), environmental (carbon sequestration, ecosystem services), or nutritional (protein, calories, etc.) (Molden et al. 2010). It is important to distinguish between water depleted and water diverted or applied, because not all water diverted (or supplied) to irrigation is depleted. Recoverable losses (such as surface runoff, deep percolation, etc.) can be reused within the same domain or at a higher landscape scale. More specifically, depleted water includes evaporation, transpiration, water quality deterioration, and water incorporated into the product or plant tissues. Water is not only defined by its amount, but also by its quality and the time it is available. Various water qualities have different productivities and it is necessary to establish some benchmarks and thresholds to standardize the unit of water for comparison. The timing of the application has a notable impact on WP. Here, the storage, (in the soil, in groundwater aquifers, or in surface storage) plays an important role in applying water to crops in time to maximize WP.

It is now well understood that WP is a scale- or level-dependent issue requiring a multidisciplinary approach (Molden et al. 2010). Drivers to improve WP vary with scale. At the field scale, it is desirable to maximize the biophysical WP of a specific crop or product. At the farm level, the farmer would like to maximize the economic WP from the whole farm, involving one or multiple crops or products. At the country level, the drivers for improved WP are food security and exports. At the basin level, competition between sectors, equity issues, and conflicts may drive WP issues. It is important to note that the WP concept provides a standardized way of comparing crops and production areas and for determining what best to grow and where. Determination of cropping patterns should take into consideration drivers at all scales and all types of WP relevant to the population.

From land to water productivity

In water-scarce areas, water, not land, is the most limiting resource to agricultural development. Accordingly, the strategy of maximizing agricultural production per unit of land (land productivity) may not be appropriate for water-scarce areas. Instead, a strategy based on maximizing the production per unit of water is more relevant (Fig. 2). Fortunately practices for increasing WP also improve land productivity to some extent. A trade-off needs to be made to optimize the use of both water and land resources (Oweis and Hachum 2009). This will require substantial changes in the way we plan and implement agricultural development, which will require a paradigm shift in national policies regarding water use and agriculture.

FIGURE 2



Relationship between water productivity and land productivity for durum wheat in a Mediterranean environment. Source: Zhang and Oweis 1999.

These changes can be achieved in the following ways (Kijne et al. 2003):

- **Increasing the productivity per unit of water consumed** through improved crop varieties; alternative crops (by switching to crops with lower water demand, or to crops with higher economic or physical productivity); deficit, supplemental, or precision irrigation; improved water management with better timing of irrigation; optimizing non-water inputs (such as agronomic practices, policy reform, and public awareness)

- **Reducing non-beneficial water depletion** by reducing evaporation from soil surfaces in irrigated fields and from fallow land; reducing water flows to sinks (such as salt lakes and the sea); minimizing salinization of return flows and shunting polluted water to sinks to avoid the need to dilute with fresh water; reusing return flows through gravity and pump diversions to increase the irrigated area.

- **Reallocating water among uses**, including from lower- to higher-value uses which can dramatically increase the economic productivity of water; tapping uncommitted outflows to be used for productive purposes and improving the management of existing facilities; policy, design, management, and institutional interventions to reduce delivery requirements; adding storage facilities to store and regulate the use of uncommitted outflows.

POTENTIAL WATER-PRODUCTIVE OPTIONS

Research has shown that a cubic meter of water can produce several times the current levels of agricultural output through better water management. This is especially relevant when considering benefits beyond the biophysical and including those of an economic and environmental nature (Ilbeyi et al. 2006).

Deficit irrigation

Deficit irrigation is a practice in which irrigation is deliberately scheduled to provide less than full crop water requirements, exposing the plants to some moisture stress, and somewhat lowering the crop yield per unit of land (lower land productivity). It has been found, however, that if deficit irrigation is well scheduled, the percentage reduction in yield arising from the reduced amount of irrigation is smaller than that of the associated water saving. This means that deficit irrigation results in more yield per unit of water used (higher WP) (Fig. 3). This water saved could be used to irrigate new lands – as land is usually more limiting than water – and thus produce more food from the water available.

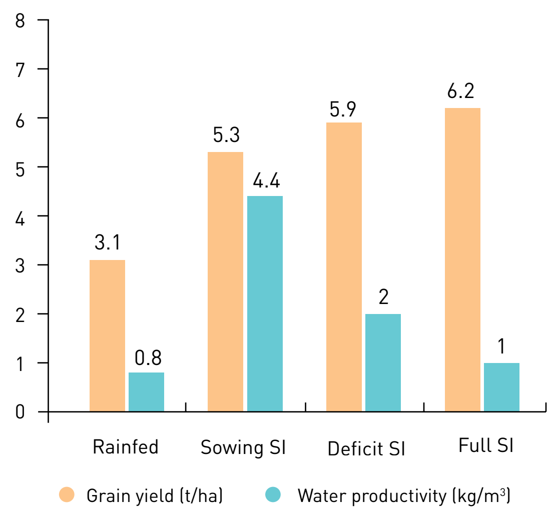
The highest wheat WP for applied irrigation was obtained at rates between one third and two thirds of that achieved with full irrigation, in addition to rainfall (Pereira et al. 2002). However, guidelines for crop water requirements and irrigation scheduling to maximize WP are yet to be developed for the important crops in dry areas. In particular, it is necessary to further develop the water production functions for various crops and work with economists on evaluating the merits of deficit irrigation and its optimization. National policies, however, need to be adjusted to reward farmers using deficit irrigation by maximizing their returns with improved WP.

Supplemental irrigation

Supplemental irrigation can substantially increase yield and WP by using limited amounts of water, applied during critical crop growth stages, to alleviate moisture stress during dry spells. Unlike full irrigation, this practice is used in rain-fed areas where precipitation is the main source of water for the crops and farmers normally practice dryland farming if no water source for irrigation is available. The average WP of rain in wheat cultivation in the dry areas of West Asia and North Africa ranges from about 0.35 kg to 1.00 kg of grain per cubic meter. However, water used in supplemental irrigation yields more than 2.5 kg of grain per cubic meter. This means that in the same environment, supplemental irrigation gives a WP that is twice as high as full irrigation (Oweis and Hachum 2009).

In the highlands, supplemental irrigation can be used to plant winter crops early, thus avoiding frost and improving yields. In the highlands of

FIGURE 3



Impact of deficit irrigation and early sowing on water productivity in rainfed systems. Source: Ilbeyi et al. 2006.

FIGURE 4

Runoff strips water-harvesting system for field crops in Aleppo, northern Syria. Photo: Theib Oweis, 2003.

Turkey and Iran, early sowing with 50 mm of supplemental irrigation almost doubled the yields of rain-fed wheat and barley, and gave WPs as high as 3-4 kg per cubic meter (Ilbeyi et al. 2006). Clearly, water resources are better allocated to supplemental irrigation when other physical and economic conditions are favorable.

Rainwater harvesting

Precipitation in much of the dry areas is generally too low and poorly distributed for viable crop production. One potential solution is water harvesting, which is defined as "the process of concentrating precipitation through runoff and storing it for beneficial use". This brings the amount of water available to the target area closer to the crop water requirements, increasing WP and the economic viability of crop production. In areas with higher rainfall much of the water flows as runoff, eroding fertile soils and leaving the soil profile with little moisture for plant growth. With climate change, rainfall intensities are expected to increase, making things even worse. Water harvesting reduces the runoff velocity and allows more time for infiltration, increasing soil water storage and combating land degradation (Oweis et al. 2012) (Fig. 1 and 4).

Alternative cropping patterns

Current land use and cropping patterns must be changed if more food is to be produced from less water. New land use systems that respond to external as well as internal factors must be developed based on water availability. These systems should include greater use of water-efficient crops and varieties, and more efficient crop combinations. The choice of alternative crops and farming systems should be based on a careful analysis of the biophysical factors as well as the returns from the water used, including income, social, and environmental aspects. New cropping patterns, in particular, must be introduced only gradually, and will often require policy support to encourage adoption (Molden et al. 2010). In cases of extreme water scarcity it becomes necessary to supplement national food production with imports of "virtual water" in the form of products that are less water demanding and less productive nationally.

Precision agriculture and irrigation

Precision here is meant to indicate the close control of the amounts, the timings, and the variability of application of water and other agricultural inputs to the crop and the system. It provides a way of monitoring the food production chain and managing both the quantity and quality of agricultural produce (Adamchuk and Gebbers 2010). Improved technologies that are currently available can at least double the amount of food produced with no increase in water consumption, thereby doubling WP. Implementing precision irrigation on laser-leveled land with uniform fertility and other techniques can substantially improve water application and distribution and result in high WP. Spatial variations, at the field level, of nutrients and soil-water can be minimized with precision agriculture, resulting in better management and improved outputs (Pereira et al. 2002).

CONCLUSION

"Business as usual" is no longer an option for agricultural water management in the water-scarce MENA. Unless strategic changes are made, the region will face increasing water and food insecurity. New thinking should drive new strategies and approaches, backed by concrete action at country and local level. Regulatory and legislative reforms in the water sector are needed, rationalizing use and attracting more investment while protecting the most vulnerable sections of the population. Policy support and funding for research and building human and institutional capacity are essential to stimulate technological innovation. Local policies often contribute to the slow adoption of available technologies. Policy reforms can bring about a substantial change in the way we manage water resources.

The region will soon face a water crisis unless the following strategic changes are made:

- Change the emphasis from land to water. Policies should foster this change by creating an enabling environment for adoption whereby farmers maximize their profit.
- Change current land use and cropping patterns to more water-productive crops and cropping systems.
- Change the way water is valued to truly reflect the conditions of scarcity.
- Change trade policies to import goods with a high water demand.
- Change the attitude towards regional cooperation.
- Change from a disciplinary to an integrated approach.

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ENDNOTES

1. The ratio of grain to biological yield.

Where are you from little river?
I’m from that mountain.
What was your grandpa’s name?
Cloud in the sky.
Who is your mother?
The North Wind
Why have you come down to the village?
To water the fields and turn the mills.
Stay, so we can see you a little, dear little river.
I’m in a big hurry to go and meet the sea.

TRADITIONAL GREEK CHILDREN’S SONG

13. Integrated Development of Wadi Systems in Lebanon

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Abstract

It is estimated that if current trends continue, Lebanon will face chronic water shortages by 2025. The hydrographic characteristics of Lebanon – mountainous terrain with many rivers and wadis – lend themselves to the development of the country's wadi systems. The fifteen rivers are used to varying degrees, but the twenty major wadis are still mostly underutilized and if properly managed, could produce an additional 750 million cubic meters of water per year, representing a 25 percent increase in the country's water resources. A precise assessment of the optimal techniques for such a project, given the natural and social environment, requires extensive field studies and pilot-scale projects of the proposed techniques.

KEYWORDS: RAINFALL-RUNOFF, WADIS, SURFACE WATER

FIGURE 1

Wadi Ain Raha, Lebanon, 2011. Source: Eileen Hofstetter.

INTRODUCTION

The terms *wadi* and *oued* are used to designate valleys in arid and semi-arid regions through which an intermittent stream of water flows in direct response to rain events. About 95 percent of the Arab countries are situated in such regions and their hydraulic network consists mainly of wadis that are dry for most of the year (Kallel 2002). Other streams are characterized by permanent or seasonal flows with a base flow that is generally small compared to the peak flow. The network structure is disintegrated and presently contains many closed basins. In some cases these basins still connect (during high flows) but in arid regions the classical notion of catchments loses all significance.

GENERAL CHARACTERISTICS OF WADI SYSTEMS

Wadi systems in Arab countries can be divided into three types: coastal, interior and the Mediterranean wadi, which is a subset of the coastal wadi and more common in mountainous regions around the Mediterranean Sea.

Coastal wadis have their sources in the mountain ranges along the littoral of the Atlantic Ocean, the Mediterranean Sea and the Gulf of Oman. They cover about 12,000 km of coastline. The average length of their stream does not exceed 100 km from the source to the sea. The beds of these wadis have slopes of 1-5 percent, and are composed of rocks, gravel and sand which are more or less consolidated, ending with finer formations (silt and fine sand) in the coastal regions. The areas of these different wadis vary from 50-1,000 km^2 and in some regions they can reach several thousand square kilometers (Kallel 2002).

Floods of coastal wadis are rapid and sudden with peak flows of 200-300 m^3/s and an average duration of six to twelve hours depending on the rain event and the size of the catchment. In some geographical zones, these floods can occur in spring, winter or even autumn. Some flows can occur during the summer following violent and repeated events. In comparison with other wadi types, coastal wadis have the best water potential, estimated to be around 15-25 million km^3/year (Ibid.).

Interior wadis originate on the leeward sides of mountain ranges along the Mediterranean Sea, the Red Sea, the Gulf of Oman and in the Atlas Mountains. Some cross the interior plates and alluvial deposit levels to reach the edges of the desert or interior plains. Other wadis go through the isolated interior mountains. Some wadis reach major rivers such as the Nile and Euphrates, while others flow to interior closed lagoons, such as *chotts* (Algeria), *sebkhas*, and *gaaraets* (Tunisia). The length of interior wadis is 200-500 km with slopes of 0.5-1 percent. These wadis have a lower water potential than coastal wadis due to the reduced precipitation they receive and the relatively flatter slopes than their coastal counterparts (Ibid.).

Mediterranean wadis are ephemeral streams that occur in parts of the Mediterranean region. Geomorphologically, these basins are small (several hundred kilometers), with steep slopes, wide valleys and a braided channel morphology. These systems, which are usually dry for most of the year, become particularly active during high rainfall when flood events occur (Belmonte et al. 2001). Fissuring and karstification, typical of the Mediterranean region, favor infiltration and percolation through to karstic aquifers unconnected to stream channels. Although runoff generation in these basins is relatively high, it represents only a small part of the rainfall over the basin. This is due to losses through evapotranspiration and infiltration through the karstic permeable structure. Streams in Lebanon are of this type.

In some mountainous basins, the narrow valleys typically accumulate alluvium, forming aquifers with limited depth and width that can however be spread out over many square kilometers. These aquifers fed by seasonal flows constitute an easily exploitable source of water. Above low transmission zones in the wadi or at major faults, springs can be found in the wadi bed, giving rise to base flow. This base flow can infiltrate again downstream in sections of the wadi bed that are highly permeable (Kallel 2002).

INTEGRATED DEVELOPMENT OF WADI SYSTEMS

The development of wadi systems can only be sustainable as part of an overall water policy and water resources management plan. The integration of wadi systems into the water resources planning effort has to be part of an integrated water resources policy which takes into account a number of interrelated technical, economical and social aspects, including water resources assessment, planning, demand management, the assessment and implementation of legislation, and financial and institutional reforms (Chen et al. 2005; Ministry of Agriculture 2003; Beniba 2002; ; and Dunne and Leopold 1978).

In developing wadi systems as water resource assets, consideration must be given to their natural and anthropogenic characteristics. Natural aspects of concern are the physiographic characteristics of the wadis being managed together with precipitation, erosion and sedimentation potential, evapotranspiration potential within the wadi, expected flows and recharge, etc. Management of human activities within wadis must be addressed in any development plan to assess the impact of the wadi management plan on the people living and working in the area. Thus, the socioeconomic perspective becomes a key component of such plans.

RAINFALL-RUNOFF PROCESSES IN WADIS

As indicated earlier, the amount of rain falling in the wadi watershed is the dominant factor in determining the magnitude of flows in wadis (Tarolli et al. 2012 and Al-Weshah 2002). Al-Rawas and Valeo (2010) found that the effect of key physiographic characteristics such as drainage area, wadi slope, watershed mean elevation, and land use decreased as the magnitude of the flow increases.

Flash floods are common in the Mediterranean region (Tarolli et al. 2012) and have been catastrophic to many communities where development has encroached on the flow path of wadis (Sen 2008). Thus there is a need to better assess flood risk and understand the processes behind such events (Tarolli et al. 2012). Al-Rawas (2009) indicated that there are gaps in the understanding of flash floods in wadis. These gaps are mainly related to the understanding of rainstorm characteristics in arid and semi-arid regions and incomplete understanding of wadi channel processes.

WATER RESOURCES IN LEBANON

Compared to other countries in the region, Lebanon has abundant precipitation in the form of rain and snow. Nearly all of the country's water resources originate from rainfall and snowmelt that recharge groundwater and feed a multitude of streams and rivers that are mostly contained within the nation's territories. Lebanon's climate is typical of the Mediterranean region and is characterized by four distinct seasons. It has a short rainy season followed by a relatively long dry period. The physiographic features of the country have a marked effect on water resources and their distribution throughout the country. The country's distinct features are its two parallel mountain ranges running north to south: Mount Lebanon in the west and the Anti-Lebanon in the east. The Mount Lebanon range is separated from the Mediterranean by a narrow coastal plain, while the Beqa'a Valley separates the Mount Lebanon range from the Anti-Lebanon.

FIGURE 2

Wadi Qadisha, Lebanon, 2012. Source: Eileen Hofstetter.

Rainfall in Lebanon is greatly influenced by the country's physiographic features. The coastal plain and the western slopes of the Mount Lebanon mountain range receive the highest amount of rainfall (600-2,000 mm). Next is the southern section of the Beqa'a (600-1,000 mm). The plain's middle and northern portions have less rainfall (200-600 mm) and the Anti-Lebanon receives the least amount of rain. In all regions, rainfall is concentrated in a very short period between November and April. Typically, January is the wettest month followed by December and February. The greatest evaporation rate occurs in the months of July, August and September (Ministry of the Environment 2001). In a normal year, about 47 percent of rainfall over the country is estimated to flow to the sea, or to neighboring countries through the rivers and groundwater (Ministry of Energy and Water 2012).

Snow, especially at high altitudes, distinguishes Lebanon from most other countries in the Arab world. It is an important factor since it prolongs the period of precipitation-caused flow and allows more time for infiltration. This prolongation of flow allows the use of part of this water during spring. The prolongation of the infiltration period and consequently the increase of infiltration will increase base flow of rivers in terms of time period and quantity. Snow also represents practically the only natural surface storage in Lebanon. In general, at high altitude the effect of snow is similar to a delay of rainfall of three to four months. This can be seen, for example, in the comparative study of rain and flow of the Yammouneh, where flows following snowmelt are delayed by about four months in comparison to that induced by rainfall (Yordanov 1962).

CONSTRAINTS FACING LEBANON'S WATER SECTOR

The water sector in Lebanon faces several constraints and problems, which need to be addressed through an integrated approach that combines practical technology with political and social support to avoid water shortages in the future. The major difficulties include: increasing water scarcity, deterioration of water quality and poor management of the water sector.

Demands on the limited amounts of available water are increasing with a growing population, an expanding economy and larger irrigated areas. If current demand and management trends continue, the water balance for Lebanon is expected to go into deficit by 2025 (Comair 2009). Irrigation accounts for most of the water losses. This is partly due to the fact that 70 percent of irrigated areas use inefficient, traditional surface irrigation methods (Farajalla and Khoury 2007). Further, water supply network losses are still significant, reaching more than 50 percent in some places.

Water quality deterioration

Water quality is as important as quantity, since quality affects usage and vice versa. However, information about water quality in Lebanon is limited. According to a 2001 UNICEF report on water quality, 60-70 percent of all water resources in Lebanon are affected by bacterial contamination. Surface and groundwater are affected by the discharge of untreated sewage, especially in the mountainous rural areas (Ministry of Agriculture 2003).

To meet increasing water demand, groundwater withdrawal by farmers and others has become excessive and is uncontrolled. As a result, severe lowering of the water table has been noted especially in the Beqa'a, and there is saltwater intrusion along the coast – sometimes reaching several kilometers inland. In addition, excessive and unregulated use of fertilizers and pesticides has also contributed to a diminishing water quality.

The uncontrolled disposal of solid waste in watersheds has also led to the contamination of river basins, through leachates seeping from dumps into groundwater and streams (Ibid.). The Ibrahim River, Litani River and Beirut River are considered the most polluted (World Bank 2003). Industrial pollution is also significant. Two categories can be cited. The first is the surface disposal of liquid effluent, which infiltrates through the bedrock into the groundwater. The second is from leaky underground gasoline storage tanks and the uncontrolled surface dumping of waste oils and petroleum by-products and residues (El-Fadel 2002).

Poor management of the sector

The water sector in Lebanon has suffered from the absence of a coordinated policy governing current and future water use. There are however efforts to remedy the situation, such as the E.U. attempts to improve the water sector's institutional capacity through the Investment Planning Programme - water (IPP-water) and the water-quality aspects of water resources. These culminated in the publication in 2012 of a National Water Sector Strategy, which aims to enhance supply by building storage facilities (mainly dams) and managing demand through improved irrigation practices, treatment and reuse of wastewater, and management of groundwater extraction. Nevertheless, major areas of concern remain, and there are areas that need to be addressed that are beyond the scope of this article. They include:

- Fragmented institutional arrangements
- Lack of appropriate legislation
- Mechanisms for resolving inter-sectoral water allocation conflicts
- Inefficient cost recovery and wasteful operational performance
- Lack of data on available water resources
- Great losses in water, due not only to bad management but also to the geography of

the country, where the steep terrain makes it more difficult to harness water. Losses to the sea account for 700 million cubic meters per year (World Bank 2003).

With all these constraints facing Lebanon's water sector, the establishment of a clear and well-defined policy and management plan is imperative.

DEVELOPMENT OF WADI SYSTEMS IN LEBANON

Lebanon will need to develop its water resources in a more effective and sustainable manner to avoid water shortages by 2025. One of the elements of such a development strategy could be to make full use of the country's major and minor wadi systems.

Currently no concerted efforts at wadi development have been carried out in Lebanon. Some individuals have tried to tap into the seasonal flow of these wadis but to a limited extent and with limited success due to the relatively high cost that is incurred in setting up these projects and the limited return on their investment. Flows through these wadis mostly end up in the Mediterranean.

As these wadis are spread throughout Lebanon, they are subject to the wide variations in rainfall throughout the country. Average rainfall over major wadis ranges between 1,350 mm in some northern wadis to around 700 mm in southern ones. Wadis in the easternmost part of the country average a little over 600 mm of rainfall. Land use in the wadis also varies according to the region in which they are located. The dominant land cover in most wadis is forest. However, wadis in northern Lebanon tend to have a higher rate of residential areas, such as Wadi Awik in the north, which is 85 percent residential. The soils of the wadis are shallow and calcareous with some infusion of clays. This has produced some soils that have low infiltration rates.

The objective of developing wadi systems in Lebanon is to augment water resources by tapping into the wasted flows of minor and major wadis. However, this endeavor should be carried out in a sustainable manner. To this end, traditional methods, explained in the paragraphs

FIGURE 3

Nahr Ibrahim, Lebanon, 2011. Source: OadrienvalentineG.

that follow and already applied in other countries are recommended for use with some modifications. These traditional methods have proven their technical sustainability. The socio-economic aspect of wadi development must also be addressed.

While there are no specific studies of Lebanon's wadis, a number of Mediterranean countries have worked on this issue and the recommendations for wadi development are based on these studies.

The steep slopes and rapid flows of wadis in Lebanon limit the options of techniques that can be used. The main aim of techniques used in wadi development in Lebanon is to divert or slow water flowing through the wadi. To this end, retardant or diversion structures are needed such as:

- *Permeable rock dams* to hold back water and allow it to spill over to adjacent fields where it could be used either for irrigation or groundwater recharge.
- *Water-spreading bunds* are applied where runoff discharges are high. They divert water into an area where it is released. This water is either stored, used for irrigation, or as groundwater recharge.
- *Trapezoidal bunds* are used to enclose larger areas (up to 1 ha) and to impound larger quantities of runoff which is harvested from an external or "long slope" catchment
- *Terracing of wadi slopes* may be used to slow down flow to an extent that would allow farmers and others to extract water from the wadi while water is flowing.

On a micro or field level similar water-holding structures may be used, but at a smaller scale the following methods may be used:

- *Negarim microcatchments:* diamond-shaped basins surrounded by small earth bunds with an infiltration pit in the lowest corner of each.
- *Semi-circular bunds:* earth embankments in the shape of a semi-circle with the tips of the bunds on the contour, which are typically used for rangeland rehabilitation or fodder production.
- *Contour ridges for crops:* contour furrows or micro-watersheds.
- *Contour stone bunds:* used to slow down and filter runoff, thereby increasing infiltration and capturing sediment.

The ultimate aim of developing wadis in Lebanon is to ensure that the rural population will have adequate amounts of water for irrigation and domestic use. The additional water that these projects will provide will raise the income levels of farmers by increasing the productivity of their land. This increase may come about either through an increase in the planted areas or through the increased yield of crops that were formerly rainfed. Moreover, the additional water will have an impact on the health of farmers and their environment. Farmers who had to rely on untreated sewage to irrigate their crops can use the additional water for such irrigation. Further, water from the development of wadis can be tapped into for household use. This will give rural population access to water that was not previously available.

Implementation of these practices in wadis can only be achieved through the active participation of all stakeholders from the inception of the project to its completion. This allows the people most affected by the project to have a say in its development and gives them a sense of ownership. It will ensure their livelihood and should raise their standard of living, thus reducing the lure the city and migration to urban environments in search of a better life.

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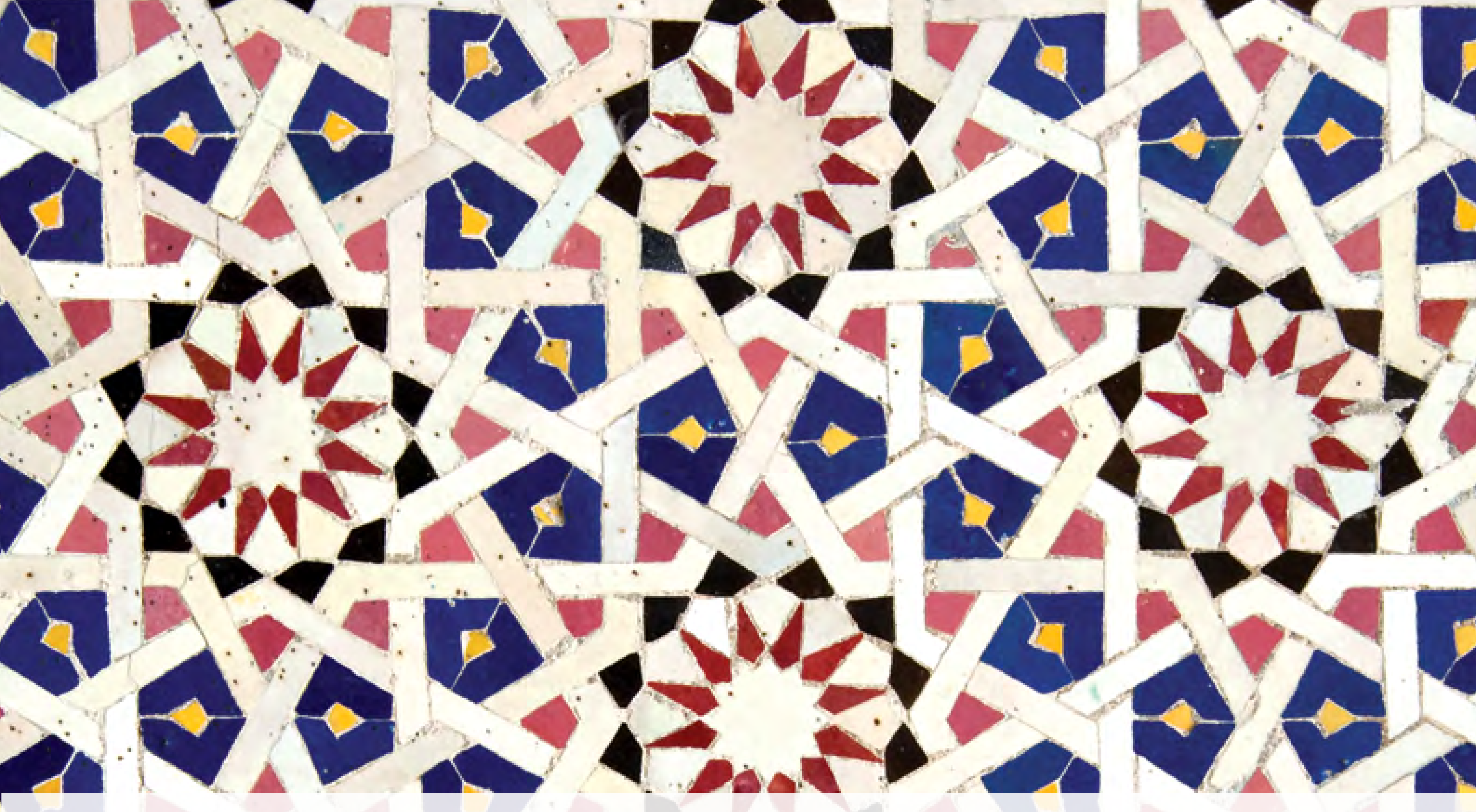
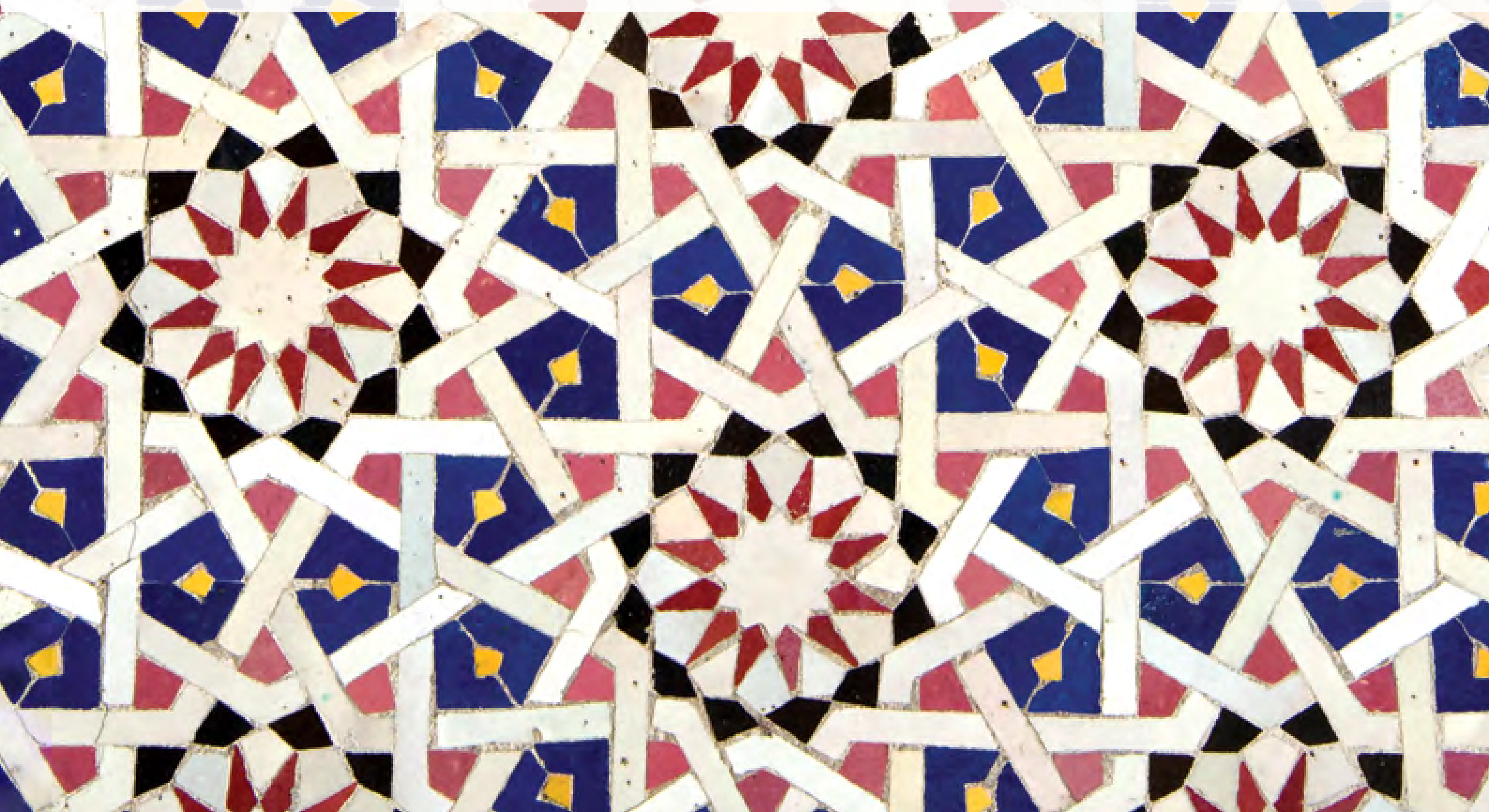


Water is the blood in our veins.

LEVI ESHKOL, ISRAELI PRIME MINISTER, 1962

Rabbi Shimon Bar Yochai said: “Three things are of equal importance - earth, humans and rain.” Rabbi Levi ben Hiyyata said “without earth, there is no rain, and without rain, the earth cannot endure, and without either, humans cannot exist”.

MIDRASH B’RESHITH RABBAH 13:3



Abstract

Overexploitation, pollution, and poor water quality contribute to the rapid deterioration of the water situation in Israel and Palestine, which already affects millions of Palestinians in the Occupied Palestinian Territory. This article discusses the root causes of the declining water supplies, thereby highlighting Israel's policies and practices that have been instrumental in gaining, maintaining, and consolidating exclusive control over and access to the shared water resources in the region. While Israel continues to illegally exercise sovereign rights over the Palestinian share of the water resources, internationally supported efforts are made in the political arena to negotiate – among others – the issue of water. Many past attempts, most notably the Oslo Accords signed in the early 1990s, have failed, in part because of a lack of foundation in international law. Future attempts are likely to suffer the same fate until a genuine commitment is made to base negotiations on the Palestinian people's sovereign rights over its resources and to reform the relationship between the parties to one of equal partnership in the administration of water resources based on equitable and reasonable standards.

KEYWORDS: PALESTINE, ISRAEL, WATER, OCCUPATION, NEGOTIATIONS, INTERNATIONAL LAW

14. Turning Off the Palestinian Taps: Israel's Predominance over the Allocation and Management of Palestinian Water Resources

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INTRODUCTION

Since the early 1990s, water experts have been predicting that drinking water supplies in the Occupied Palestinian Territory (OPT), Israel and Jordan will no longer meet demand by 2040 based on the expected population growth (Scobbie 1997: 231). Although intended to serve as a crude awakening to the impending water crisis in the region, which will undoubtedly affect millions of already vulnerable people, these predictions stand in stark contrast to the water available in the region.

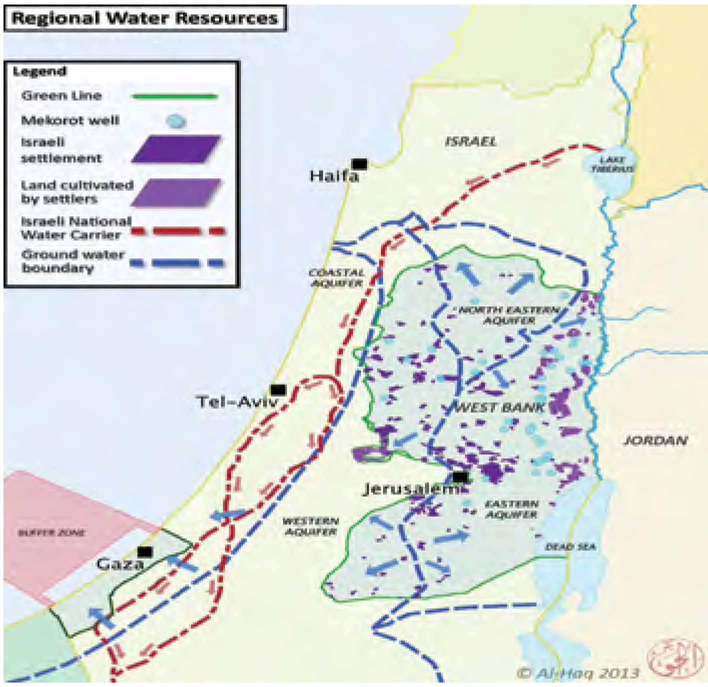
Underneath the lands inhabited by Israelis and Palestinians, natural fresh water flows abundantly. Better known as the Coastal Aquifer and the Mountain Aquifer, the two groundwater resources are considered international watercourses by virtue of their transboundary nature. The Coastal Aquifer is located underneath the coastal plain of Israel and the Gaza Strip, forming a unitary whole. The Mountain Aquifer extends across both sides of the 1949 Armistice Line (also known as the Green Line), the internationally recognized boundary between Israel and the OPT, and is divided into three basins.

The Western Aquifer Basin is by far the largest and most productive aquifer, yielding more water than the North-Eastern and Eastern Aquifer Basins together. Its water originates from the hills of the northern West Bank and flows downstream crossing the Green Line into Israel. The Eastern Aquifer lies almost entirely within the West Bank with no relevant in- or outflows from Israel (McCaffrey 2007: 319). In addition to groundwater resources, the Jordan River is the region's most important shared surface water resource. Despite these three major productive water resources, at present the water sector in Israel and the OPT "is characterized by highly asymmetrical overexploitation of damageable shared water resources, exhaustion of long-term storage, deterioration of the water quality and increasing levels of demand driven by high population growth and accompanied by decreasing per capita supplies" (Koek 2013b: 21) (Fig. 1).

Drawing on research, including interviews and primary fieldwork, carried out in Palestine and Israel between 2011 and 2014, the first part of the article provides a factual overview of the current water situation in the OPT, as well as insights into the circumstances of those directly affected by the lack of access to water in the region by discussing the case of the Palestinian village, Sousiya, located in the West Bank.

The second part of the article contextualizes Israel's policies and practices in light of the ongoing occupation and sets out to explore the root causes of the deteriorating water situation in Israel and the OPT. Indeed, for decades, the general water situation in Israel and the OPT has been the subject of much scholarship, public debate, and – let us not forget – negotiation between the representatives of both parties to the conflict. Every effort has been made to research, document, and predict the state and development of the shared Coastal (Messerschmid 2011a; Messerschmid 2011b; UN Country Team in the OPT 2012; UNRWA 2009) and Mountain Aquifers (World Bank 2009; ARIJ 2012; McCaffrey 2007; Abouali 1998; Stein 2011; Scobbie 1997), as well as the Jordan River flow and its surface catchment area (FAO 2009; Phillips et al. 2007a; Phillips et al. 2007b). However, the various legal frameworks that protect and promote access to clean and sufficient water have been largely overlooked. This is extremely concerning,

FIGURE 1



Map of the shared water resources in the region (Koek 2013b: 22). Designed by Tom Palmer. Used with permission of Al-Haq ©.

On average, a Palestinian in the West Bank consumes 73 liters per day compared to 300 liters for an Israeli in Israel proper and 369 liters for Israeli settlers residing in settlements in the West Bank.

considering the fact that international law is crucial to protecting the right to water. In more detail, section three explores the international legal obligations incumbent upon the Occupying Power vis-à-vis the occupied population, and examines how international water law provides a framework for the protection of shared water resources, ultimately to guarantee the individual's human right to water.

Finally, the article examines the factors that have contributed to the failure of past attempts to address the water crisis in the region, and concludes that respect for international legal frameworks can help avoid past mistakes and ensure that the human right to water is protected and promoted.

THE REALITY OF TODAY

Unequal water sharing in the West Bank

Located in the South Hebron Hills of the West Bank, the Palestinian community of Sousiya, Hebron Governorate, is made up of just over 200 people. The community is not connected to the water network and there are no nearby water filling points. As a result, residents rely on traditional rainwater harvesting techniques during the rainy season, but are forced to purchase expensive water from tanker trucks during the dry summers, leaving the average household to spend up to a third of its yearly income on water (Fig. 2).

Water consumption in Sousiya stands at 28 liters per capita daily (lpcd) (OCHA 2012: 3), well below the World Health Organization's minimum standard of 100 lpcd for domestic use. The residents of Sousiya depend on herding and agricultural activities, but struggle to keep their animals alive and their crops irrigated because of the lack of water.

Sousiya is not the only community that struggles to survive with the limited amount of water available for domestic purposes. The residents of al-Hadidiyya, a herding community with a population of around 200 residing in the Jordan Valley, struggle with only 22 lpcd, while Israeli settlers in *Ro'i* settlement, about 150 meters west of the village, have access to 431 lpcd (Al-Haq 2011). Or take the West Bank village of Kufr al-Deek, Salfit Governorate, located 300 meters from *Ariel*, which is one of the largest settlements in the West Bank. Kufr al-Deek's residents already survive on as little as 23 lpcd while the settlers in *Ariel* have enough water to build swimming pools, but when water supplies run low during the hot summer months, Israel's national water company *Mekorot* safeguards *Ariel's* unlimited and uninterrupted supply at the expense of Kufr al-Deek's households by cutting their water supplies for extended periods of time (Koek 2013b: 49).

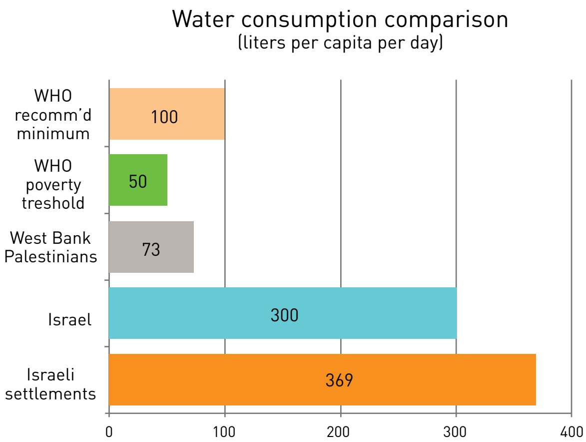
Unfortunately, lack of water for Palestinian communities is a common occurrence across the entire West Bank. On average, Palestinians in the West Bank consume 73 lpcd compared to 300 lpcd for Israelis in Israel proper (Amnesty International 2009: 29) and 369 lpcd for Israeli settlers residing

It has been more than twenty years since the signing of the Oslo Accords and for Palestinians living in the OPT, the struggle for water serves as a constant reminder of the failed promises of the 1990s 'peace agreement'.

FIGURE 2

Palestinian residents of Sousiya village, Hebron Governorate, are forced to rely on water from tankers, while neighboring settlers are connected to a water network. The pipes that connect Suseya settlement to the water network run through Sousiya village, October 2013. Photo: Elisabeth Koek ©.

FIGURE 3



Water consumption comparison in the region (Koek 2013b: 52). Designed by Tom Palmer. Used with permission of Al-Haq ©.

in settlements in the West Bank (Isaac and Hilal 2011: 422-423). In the West Bank, including East Jerusalem, the more than half a million settlers consume approximately six times the amount of water used by a Palestinian population of almost 2.6 million in the same area (Koek 2013b: 51) (Fig. 3).

The discrepancy in water use between Palestinian communities and Israeli settlements is even greater when water used for agricultural purposes is taken into account. Al-Oja, a Palestinian village in the Jordan Valley, which used to feature lush green fields of crops due its close proximity to al-Oja Spring, provides a stark example of this discrepancy. Nowadays, al-Oja's farmers only have sufficient water supplies to irrigate a portion of their highly fertile lands, leaving large areas to lie fallow. Like many others in the Jordan Valley, farmers here have resorted to low water-intensive – less profitable – crops, such as potatoes, cabbage, beans, cauliflower, okra, and zucchini. Neighboring settlements in the Jordan Valley have plentiful water available to cultivate all their lands with crops that require significant amounts of water, often received against subsidized prices by the Israeli government. Illustrative are the dates of *Tomer*, the grapes of *Ro'i*, the bananas of *Shadmot Mehola*, and the watermelons of *Na'aran* settlement (Fig. 5).

Denial of permits for water infrastructure in the West Bank

In parallel to the discriminatory allocation of water, Israel actively prevents the construction and maintenance of water infrastructure in 62 percent of the West Bank, earmarked Area C.[2] Containing the bulk of Palestinian agricultural and grazing land, water resources and underground reservoirs, all construction in Area C requires prior approval from the Israeli Civil Administration, a body tasked with the implementation of Israel's government policy in relation to land use and planning in the West Bank. This includes all new water facilities or rehabilitation of existing ones, even those pre-dating the 1967 occupation of the OPT. Any water structure built or rehabilitated without a permit – permits that are systematically denied – risks demolition. This practice has also prevented humanitarian organizations from carrying out their mandate. The likes of Oxfam, Save the Children, UNICEF, and local organizations funded by third states, are often left with no other option than to proceed without a construction permit, putting already vulnerable communities at risk of demolition. In practice, this means that for a Palestinian water project, permission must be obtained from an additional body, further diminishing prospects of approval.[3] As Israel has extended its domestic laws to apply to the settlements, prior approval from the Israeli Civil Administration is not required for any infrastructure constructed for the benefit of the settler population. Moreover, all settlements, most of which are located in Area C of the West Bank, are connected to the water network for domestic purposes. At the same time, Israel has developed wells, mainly concentrated in the Jordan Valley, and allows *Mekorot* to pump copious amounts of water directly from the wells to the settlements. The water is intended for irrigation of high-intensity and specialized agricultural production, enabling settlers to develop and profit from flourishing agricultural enterprises.

FIGURE 4

Al-Oja Spring used to provide water for Palestinian farmers in the Jordan Valley, but is now dry most of the year, March 2013. Photo: Tony Kane. Used with permission of Al-Haq ©.

FIGURE 5

Demolished cistern in Al-Khadar, Bethlehem Governorate, July 2012. Photo: Elisabeth Koek ©.

Demolition of water infrastructure in the West Bank

Since the early 1980s, Israel has confiscated most of Sousiya's land, which has subsequently been allocated for the establishment and expansion of *Suseya* settlement. In the process, residents have been expelled and their property has been demolished, including water infrastructure indispensable for the survival of rural and herding communities such as Sousiya.

The practice of demolitions of Palestinian property in the West Bank by the Occupying Power must not be viewed as isolated incidents, nor be seen as limited to one particular area of the West Bank. Instead, demolitions of water infrastructure are all incidents within a larger framework of a systematic plan to forcibly transfer the occupied population off their lands, thereby ridding the most fertile and water-rich areas of the West Bank of its Palestinian residents. In 2011 alone, the number of demolitions of water, sanitation and health structures stood at 89, affecting 977 Palestinians. In the following year, 56 structures were demolished. The majority of the demolished structures were cisterns and tanks used for personal and domestic functions. What is more, the majority of all demolitions in 2011 and 2012 occurred in areas allocated for the expansion of settlements (Fig. 1).

Water unfit for human consumption in the Gaza Strip

Meanwhile in the Gaza Strip, the lack of clean water is raising serious health concerns for the 1.7 million residents of the densely populated strip of land bordering Egypt and Israel. Palestinians of the Gaza Strip rely on the southern end of the shared Coastal Aquifer for water. This highly polluted and over-exploited groundwater resource remains the only source of natural water available for the population of the Gaza Strip. Well into its eighth consecutive year of Israeli closure, imposed in September 2007, the population of the Gaza Strip does not have access to the water resources from the West Bank or to the majority of materials necessary to maintain the water and sanitation infrastructure. Increasingly, especially since the destruction of the smuggling tunnels between Egypt and the Gaza Strip in July 2013, fuel shortages affect treatment of wastewater and desalination of seawater (Fig. 6 and 7).

It is estimated that 90-95 percent of the water available to the Palestinian population in the Gaza Strip is unfit for human consumption as a result of seawater and sewage infiltration (UN Country Team in the OPT 2012: 11).

With households struggling to survive under the harsh economic conditions, forced to purchase water from private vendors, waterborne diseases have become increasingly common among the population of the Gaza Strip (UNRWA 2009: 3). If the Gaza Strip remains under closure or in the absence of any alternatives, the quality of water in the Coastal Aquifer will continue to deteriorate, soon rendering the Gaza Strip unfit for human habitation (UN Country Team in the OPT 2012: 3, 11).

FIGURE 6

The wastewater treatment and desalination plants in the Gaza Strip do not have enough fuel to keep operating, Gaza Strip, February 2013. Photo: Elisabeth Koek ©.

FIGURE 7

Because of the lack of fuel to keep the wastewater treatment plants operating, sewage is often only partially treated and pumped directly into the sea, Gaza Strip, February 2013. Photo: Elisabeth Koek ©.

HISTORICAL NARRATIVE AND ROOT CAUSES OF THE DETERIORATING WATER SITUATION

A strategic occupation

From the beginning of the occupation in 1967, Israel has implemented policies and practices aimed at gaining, maintaining, and consolidating exclusive control over and access to the region's shared water resources for the benefit of its own citizens, while at the same time depriving the occupied population of the West Bank, including East Jerusalem, and the Gaza Strip access to this vital resource.

The drive to ensure access to and control over the region's major surface and groundwater resources dates back to the Six-Day War of June 1967 when Israeli forces strategically occupied lands rich in natural water resources. Indicative of the importance of the aquifers, one of Israel's first acts after the war included declaring all water resources subject to Israeli military control through a series of military orders, which are still in place today. These efforts were clearly aimed at consolidating control over the Palestinian share of the water resources as it integrated the West Bank water system into the Israeli system. The integration was completed in 1982 when then Minister of Defense Ariel Sharon transferred ownership over all West Bank water supply systems to *Mekorot* for the symbolic price of 1 NIS (approximately $0.25) (Selby 2006).

To this day, Israel continues to deny Palestinians physical access to the Jordan River and prohibits them from exploiting their equitable and reasonable share of the river's resources. The Mountain Aquifer's water resources are "currently under near-exclusive privileged use by Israeli wells and Jordan Valley settler wells", (Messerschmid 2011a: 1) as Israel extracts 89 percent of the shared Mountain Aquifer system annually, leaving a mere 11 percent for the Palestinians (UN Independent Fact-Finding Mission on Settlements 2013). By making use of its military power, Israel laid the foundations for a system of water governance that remains in place today and is characterized by discrimination in allocation of water resources, and, more broadly, Israel's unlawful exercise of sovereign rights over all the water resources of the OPT.

INTERNATIONAL LEGAL FRAMEWORK

Preliminary legal issues

Before examining the obligations of the Occupying Power vis-à-vis the occupied population, it must be noted that some commentators have suggested that the Gaza Strip is no longer occupied following Israel's unilateral 'disengagement' in 2005 (see for example Samson 2010).[4] While it is beyond the scope of this contribution to deconstruct this distortion in detail, it suffices to point to the widely accepted view, affirmed by the ICRC, the International Court of Justice (ICJ) and the various UN bodies, that Israel continues to hold responsibilities towards the population in the occupied Gaza Strip by virtue of its exercise of 'effective control' over the territory and its population, thereby triggering the application of the law of occupation.[5]

Similarly, there are still those who challenge the illegality of Israel's settlement enterprise in the OPT. In light of the analysis of the different legal frameworks applicable to the water situation in the OPT as set out below, it is necessary to reiterate the illegality of the transfer of the Occupying Power's own citizens into the occupied territory under international humanitarian law (IHL). Since Israel began the implementation of its settlement policies in the OPT, the construction and expansion of settlements has been initiated, supported and financed by the state authorities in a systematic and institutional manner. Settlement expansion is further supported by the encouragement of state authorities through social benefits and favorable economic conditions afforded to those who move to these areas. At present, there are more than half a million settlers residing illegally in the OPT.

Having reaffirmed the extent of the territory occupied and provided clarity as to the unequivocally illegal nature of Israel's settlement enterprise, I will now explore the international legal framework that ensures access to water and governs the allocation and management of water resources in occupied territory. While discussing a matrix of different sets of laws and provisions, including IHL, human rights law and transboundary water law, a record of compliance – or lack thereof – is offered, thereby providing a brief analysis of the violations committed by Israel, as the Occupying Power of the OPT.

International humanitarian law

Since Israel occupied the OPT immediately after the Six-Day War of June 1967, its conduct is governed by the rules of IHL, enshrined in the 1907 Hague Regulations and the 1949 Fourth Geneva Convention. Under the law of occupation, the Occupying Power does not replace the legitimate sovereign of the territory, and as such, does not acquire sovereign rights over the occupied territory or the natural resources therein. The Occupying Power merely acts as the *de facto* administrator of the territory and must administer the territory while preserving the sovereign rights of the occupied population – thus protecting the occupied population and their property from exploitation and depletion while occupied by a foreign power (Scobbie 1997: 229). Jurisprudence from the Nuremburg Trials reaffirmed that the Occupying Power may under no circumstances administer the territory and the natural resources to benefit its own interests.[6] The economy of the belligerently occupied territory is to be kept intact, barring carefully defined permissions given to the Occupying Power relating to the army of the occupation.

IHL also protects the property of the occupied population, thereby distinguishing between private property and public property. Wells, pumps and other water installations are considered as privately owned property, even if owned by municipalities, and are protected from confiscation and destruction by the Occupying Power. There is an exception to the near absolute prohibition of confiscation, which relates to seizure of property for the needs of the army of the occupation. Arguably, military necessity could justify the requisitioning of a well under Article 52 of the Hague Regulations – for instance to provide drinking water for the occupying forces stationed in occupied territory. However, compensation must be provided and subjection of privately owned property can "only be in proportion to the resources of the country." It is no secret that Israel regularly targets water installations in the OPT for confiscation, a particular practice that constitutes a double illegality under IHL. The property is not only used for the presence and consolidation of the settlements in the West Bank rather than "for the needs of the army of the occupation", but lack of water for Palestinian communities clearly reveals Israel's failure to manage the water "in proportion to the resources of the country" (Scobbie 1997: 278-279). Similarly, Article 53 of the Fourth Geneva Convention prohibits the Occupying Power from destroying all property in the occupied territory for any other reason than military necessity. As set out above, Israel has maintained a practice of systematic destruction of Palestinian water infrastructure in the OPT that is constructed or rehabilitated without permission from the Israeli authorities. This practice is ostensibly administrative, some would even say 'punitive', in nature, however, it would be difficult to argue that destruction of property is justified by absolute military necessity.

Communally held or transboundary water resources, such as the Mountain and Coastal Aquifers and the Jordan River, are included in the regime of publicly owned immoveable property (Cassese 1992: 431). As a result, its use by the Occupying Power is governed by the usufructuary rule. Under the usufructuary rule, the Occupying Power has the right to use and enjoy the property of the occupied population provided that the property is used to meet its security needs or to defray the expenses of the occupation (not intended as the overall costs of the military operations), and to promote the needs of the local population (Benvenisti 2003: 869). However, at the same time, the Occupying Power is prohibited from decreasing the value of the property or exploiting it in a manner that leads to its destruction (Arai-Takahashi 2009: 198). For example, the Occupying Power may use the wood or stones located in the occupied territory to build military barracks, or homes and roads for the benefit the occupied population. It must thereby ensure not to decrease the value of the forests or stone reserves. However, exporting the assets for economic exploitation is absolutely prohibited.

Israel has maintained a system of water governance carefully designed from the start of the occupation to cater to the needs of its own population, which attests to its 'self-interested administration' of the region's shared water resources. Israel not only unlawfully exploits and appropriates the Palestinian share of the water resources for the benefit of those residing in Israel and in Israeli settlements, but its practice of overexploitation and pollution has caused significant and irreparable damage to the aquifers in violation of the usufructuary rule. Water can therefore no longer be seen as the fruit of the occupied territory that can be replenished, because the underlying resource has been damaged. This significantly decreases the value of the capital of the occupied territory and permanently denies the occupied population the ability to exercise sovereign rights over their share of the water resources in violation of the basic premise of the law of occupation – preservation of the sovereign rights over the territory.

Israel's intention to permanently deny Palestinians their sovereign rights over their natural resources, which is inherent to a colonial regime, reveals itself through its illegal exercise of sovereign rights over Palestinian natural sources and further entrenchment of the settlements and their associated regime into the OPT. This demonstrates the existence of a governmental policy aimed at dispossessing the Palestinian population of their natural wealth. This orchestrated dispossession constitutes an infringement on the right of the Palestinian people to self-determination and to permanent sovereignty over their natural resources.

International human rights law

Israel consistently fails to meet its obligations under international human rights law by refusing to respect, protect and fulfill the right of the Palestinian people to water, which is derived from existing human rights treaties, to which Israel is a state party. State-sanctioned policies and practices, such as destruction of water infrastructure in the West Bank, pollution of the aquifers, reduction of water in certain areas, interfere with the enjoyment of the right to water and demonstrate Israel's lack of respect for Palestinians' right to water. Israel has also failed to protect Palestinians' right to water by failing to hold accountable settlers who have a violent history of taking over Palestinian wells and polluting Palestinian water resources, thereby allowing third-party interference with the enjoyment of the right to water. Moreover, Israel has not adopted positive measures to fulfill Palestinians' right to water. On the contrary, it continues to obstruct entry of tools and materials to rehabilitate water infrastructure destroyed during the last two attacks on the

Gaza Strip, as well as the entry of fuel into the Gaza Strip to keep the wastewater treatment plants operational. In addition, Israel's efforts to withhold water are aimed at forcibly transferring Palestinian communities from their homes to make room for the construction and expansion of Israeli settlements. As such, Israel uses water as an "instrument of political and economic pressure", a practice absolutely prohibited by international law.

Transboundary water law

Transboundary water law regulates the relationship between two states in whose territory part of an international watercourse is situated. An international watercourse must be understood as "a system of surface waters and groundwaters constituting by virtue of their physical relationship a unitary whole and normally flowing into a common terminus."[7] Individually, the Mountain Aquifer, the Coastal Aquifer, and the Jordan River constitute international watercourses by this definition as a result of their transboundary nature.

While neither Israel nor Palestine have acceded or ratified the 1997 UN Watercourses Convention, their conduct in relation to the management of the shared water resources is nonetheless subject to the obligations enshrined therein, because the provisions of the Convention have been derived from "a general practice accepted as law" (customary international law).[8] The 2008 Draft Articles on Transboundary Aquifers are also relevant in this regard and reflect many of the principles enshrined in the 1997 UN Watercourses Convention, supportive of its customary nature.[9]

The use and management of shared water resources are governed by two key principles. Firstly, states are obliged to use international watercourses in accordance with the prevailing principle of 'equitable and reasonable utilization',[10] which ensures equitable apportionment based on different factors, including, but not limited to, the natural character of the water source, availability of alternative water sources, and human dependence. Secondly, states must "take all appropriate measures to prevent the causing of significant harm to other watercourse States."[11] The 'no-harm rule' is not limited to direct harm of the watercourse, but includes impediments to the actual use of the watercourse of one state by the other, for instance in situations of excessive pumping of groundwater by one state or diversion of the flow of the watercourse upstream.

While it would be speculative to make any concrete determinations here as to how equitable apportionment looks in the case of both aquifers and the Jordan River, it is safe to conclude that Israel's predominance over allocation and management of the shared water resources does not inspire much confidence in a good-faith application of the principle of equitable and reasonable utilization. Many of Israel's efforts have gone towards diminishing Palestinian access to the shared water resources, which today stands at a mere 10 percent overall. Through the implementation of day-to-day policies and practices, Israel ensures that the remaining 90 percent stays beyond Palestinian reach. Additionally, as Israel has other water resources available and is much more technologically and economically advanced in the areas of water management and desalination than the Palestinians, a 90 percent versus 10 percent utilization ratio can hardly be considered equitable and reasonable. And while Israel continues to extract far beyond its equitable and reasonable share of the transboundary waters, causing significant harm to the watercourses through increased pollution and salinization in the process, the burden is borne by the Palestinian population.

THE OSLO ACCORDS

It has been more than twenty years since the signing of the Oslo Accords and for Palestinians living in the OPT, the struggle for water serves as a constant reminder of the failed promises of the 1990s 'peace agreement'. The Oslo Accords promised Palestinians greater access to the water resources of the OPT and to temporarily address water problems in the OPT until a 'final status agreement' was reached. However, from the get-go it should have been evident that the principles of the water-sharing agreement would not make the slightest improvement to the lives of Palestinians. Why? Simply put, because negotiations were not premised on respect for the rights of the Palestinian population.

Examining the Oslo Accords, it is immediately striking that there is no mention of water in the body of the Interim Agreement itself. This seems strange considering the obvious importance of water for both parties.[12] Instead, water is dealt with in Article 40, "Water and Sewage", of Appendix 1 of Annex III of the Agreement, which is reflective of the general architecture of the Oslo II negotiations rather than of a misguided assumption of relative unimportance. Article 40 opens with an articulation of "Israeli recognition" of Palestinian water rights in the West Bank, falsely suggesting that such recognition is a prerequisite. Let there be no confusion, Palestine holds sovereign rights to its natural resources on the basis of international law, not as a result of "Israeli recognition".

As articulated above, any water-sharing agreement between Israel and Palestine must ensure respect for the sovereign rights of the occupied population in line with IHL, and allocation and management of the shared water resources is guided by the principle of equitable and reasonable utilization and the 'no-harm rule', as well as by the general principles of international law. In light of this, the geographical limitation of the Interim Accords to only those areas of the shared Mountain Aquifer that underlie the West Bank constitutes *prima facie* evidence that international law is absent from the basis for negotiations. The Oslo Accords preserved and formalized Israel's predominance of allocation and use of the Mountain Aquifer by ensuring that there would be no reduction in the quantity of water that Israel extracted prior to 1995. By pre-emptively removing 87 percent of the Mountain Aquifer from the negotiation table before redistribution had even commenced – the unstated rationale was that the North-Eastern and Western Aquifer Basin were already fully used by Israel – the accords provide a veneer of legitimacy for Israel's continued illegal exercise of sovereign rights over the Palestinian share of the water resources (Koek 2013a). Moreover, the limited application of the Oslo II water regime to only one part of the international watercourse ignores the international legal principle of equitable and reasonable utilization between two water-sharing states.

Exclusion of the two groundwater basins as a pre-condition for any redistribution arrangements clearly displays the Accords' failure to make explicit provisions to ensure, rather than merely assume, that Israel respects the right of the Palestinians. While the Oslo Accords cannot replace the international legal framework that protects the natural resources located in occupied territory from exploitation or depletion, both parties have acquiesced to the breaches of international law that have been formalized in the conclusion of the Oslo Accords and at the same time refuse to renounce it, even after its five-year interim deadline had lapsed.

VISION FOR FUTURE EFFORTS TO SHARE WATER RESOURCES

Since the start of the occupation of the OPT, Palestinians have seen their potential for economic, social and political development heavily impeded. Palestinian communities struggle to survive with a minimum amount of water available, while settlement construction and expansion continues relentlessly. Israel unlawfully exploits and appropriates Palestinian land and water resources, while at the same time demolishing Palestinian property and systemically preventing construction of water infrastructure. The effects of Israel's discriminatory policies and practices have contributed to the de-development of local communities and through the extensive deprivation of water, Israel has made it nearly impossible for some Palestinians to remain in their communities, effectively forcing the transfer of the protected population from their homes.

The access to, use and allocation of shared water resources must not be determined on the basis of one side's dominant negotiating power over the other, but must strictly abide by international legal norms.

In the last twenty years since the conclusion of the Oslo Accords, Palestinians have been prevented from realizing their national aspirations. Israel has implemented policies vis-à-vis the Palestinian territory that undermine the spirit of the Oslo Accords and which are intended to outlast any further negotiations. It is evident that the current state of the water sector in the OPT and Israel will not improve unless structural changes are made to the use and management of the shared water resources. Ultimately, lasting structural changes will require bringing Israel's occupation of the OPT to an end and substantially reforming the relationship to one of equal partnership in the administration of water resources based on reasonable and equitable standards.

The international community, but most importantly the Palestinian negotiators, must realize that today's reality post-Oslo provides a sneak peak into the future 'final status agreement' that Israel is committed to. Unless a genuine commitment is made to base future efforts to a negotiated solution on the Palestinians' sovereign rights over their territory and its natural resources and to ensure that Palestinians can exercise their full rights in the OPT, the access to, use and allocation of shared water resources must not be determined on the basis of one side's dominant negotiating power over the other, but must strictly abide by international legal norms.

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ENDNOTES

1. This article draws from earlier works by Koek, including: Dugard, J. and Koek, E. (forthcoming 2014) Water Wars: Anti-Privatization Struggles in the Global South. In Alam, S., Atapattu, S., Gonzalez, C. and Razzaque, J. (eds.) *International Environmental Law: Perspectives from the Global South.* Cambridge: Cambridge University Press; Koek, E (2013a, 2013b). The views expressed in this article are those of the author and do not necessarily represent those of the institutions for which Elisabeth Koek has worked or currently works.

2. Following the conclusion of the Oslo Accords in the 1990s, the West Bank was carved up in three Areas. Area A and B are under full Palestinian civil control, while the majority of the West Bank remains under full Israeli civil and military control, including land registration, planning, building and designation of land use.

3. Permission for development or rehabilitation of all water infrastructure in the West Bank, whether Palestinian- or Israeli-initiated, must first be granted by the Joint Water Committee (JWC), a body established under the 1995 Oslo Accords as part of the five-year interim arrangement. The JWC is comprised of equal numbers of Israeli and Palestinian representatives and decisions should be made by consensus, granting either side the right to veto any proposal. Israel can and has used its veto power to prevent Palestinians from undertaking any substantial water projects in the West Bank. Based on a comprehensive study into the JWC records between 1995 and 2008, Selby concludes that approval rates for Palestinian projects are significantly lower than Israeli projects (Selby 2013: 7). Furthermore, when Palestinians have exercised their veto right through the JWC, Israel proceeds unilaterally with water projects that serve the settlements.

4. Israel completed the withdrawal of most of its troops and evacuation of the settlements from the Gaza Strip in September 2005.

5. Israel retains exclusive jurisdiction over the territorial waters and airspace of the Gaza Strip and full control over its land borders, with the exception of the Rafah crossing. Additionally, Israeli troops remain stationed along the borders between Israel and the Gaza Strip, enforcing the so-called "buffer zone" – an area extending over approximately 17 percent of the territory of the Gaza Strip barred to Palestinian access – and conducting regular raids into cities and villages. For a more comprehensive analysis, see Al-Haq 'Al-Haq's Rejoinder to Gisha's "Scale of Control" Report: Israel's Continued Responsibility as the Occupying Power in the Gaza Strip' (December 2011).

6. *United States of America v A. Krupp et al.*, US Military Tribunal at Nuremberg (Judgment, 31 July 1948), in *Trials of War Criminals before the Nuremberg Military Tribunals*, Vol. IX, 1342-1343.

7. Article 2(a) of the Convention on the Law of the Non-Navigational Uses of International Watercourses, annexed to UNGA, Res 51/229 (21 May 1997) UN Doc. A/RES/51/229 (hereafter: 1997 UN Watercourses Convention).

8. The ICJ declared that the 1997 UN Watercourses Convention, in its entirety, and Article 5 in particular, reflect "[t]he modern development of international law," which in turn "reflects in an optimal way the concept of common utilization of shared water resources." *Gabčíkovo-Nagymaros Project (Hungary/Slovakia)* (Judgement) ICJ Rep 1997, paragraph 78, 85, 147 and 150.

9. Draft Articles on The Law of Transboundary Aquifers, annexed to UNGA Res 63/124 (15 January 2009) UN Doc. A/RES/63/124.

10. Article 5 of the 1997 UN Watercourses Convention.

11. Article 7 of the 1997 UN Watercourses Convention.

12. It has often been said, including by Israeli officials, that control over water resources was one of the major causes of the 1967 war following escalating tensions over the completion of the National Water Carrier (NWC), a project crucial to Israel's planned growth and development of the coastal and desert regions. The NWC is a pipeline of three meters in diameter, carrying some 1 million cubic meters of water per day from Lake Tiberias in northern Israel to the coastal cities of Haifa and Tel Aviv and to the Negev Desert in the south. The NWC continues to severely affect the water supply in neighboring countries, especially Jordan, where the lower reaches of the Jordan River have been reduced to "a saline trickle, leaving Jordanian farms along its east bank desperately short of water" (McCaffrey 2007: 21).

Nonetheless,
That river kept moving backwards,
And it widened to touch the things it saw:
The last reeds,
The thirst of the herds,
The white rocks polished by its eagerness.
If it could not reach it,
It caressed all with its eyes of water.

THAT RIVER MOVED BACKWARD, ANGEL GONZALEZ

O Lord, Send us blessings from the sky
And give us water after this long thirst.
Be generous and bestow water on the thirsty
And grant water to our land,
The land of our hearts,
God, forgive our sins.

FRAGMENT OF THE MUSLIM PRAYER FOR RAIN

Abstract

Population pressure induces both climate change and alterations in the landscape. Although climate change is often considered the culprit for alterations in river flow such as increased flooding, in the case of the Blue Nile Basin and in the short term, landscape degradation and irrigation withdrawals are the cause of decreased flows during the dry season. Widespread land degradation also increases sediment concentration in rivers and, to a lesser degree, discharge during the rainy season. Along with the changing climate, the impact of changes in the landscape on the hydrology should be taken into account in future management strategies for sustainable water use and improved quality, as well as in the renegotiation of transboundary water treaties.

KEYWORDS: WATER MANAGEMENT, BLUE NILE, ETHIOPIAN HIGHLANDS, ENVIRONMENTAL SERVICES

15. Changes in Climate and Landscape in the Blue Nile Basin: What it Means Downstream

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Climate change is the defining issue of our time. Literally hundreds of publications and millions of articles have appeared on how the climate will change and how this will affect temperature, water availability and ultimately human well-being. NGOs are even being established to inform unsuspecting inhabitants in developing countries about climate change.

Despite claims by a small minority, researchers are in agreement that there is convincing evidence that anthropogenic global climate change is occurring. Many published articles also claim that climate change will be the driver of increasing floods and decreasing water availability in the future. In this article we suggest that manmade changes to the landscape have a much greater impact on the hydrological cycle (including water and sediment flows) in the short term than climate change, which is likely to only have an effect in the much longer term. This is important because decreasing greenhouse gases alone will not solve future water-related problems. It needs to be combined with improved landscape management practices and the combating of overpopulation in order to have a tangible impact on the ground. To illustrate this, we will investigate the importance of changes to climate and landscape, and other factors in the Nile Basin, one of the most water-scarce regions in the world. Without the Nile, Egypt and Sudan would have negligible global importance. The Nile is the longest river in the world with a historic water availability of around 85 billion cubic meters. The allocation of water to Egypt and Sudan in an agreement signed in 1959 was based on this amount. Around 85 percent of the water in the Egyptian Nile originates in the Ethiopian Highlands and only 15 percent comes from the White Nile. The total yearly flow of the Nile, with a drainage area 3.2 million km^2 is approximately of the same order as the Rhine, a river whose drainage area is seventeen times smaller (0.19 million km^2). However, the population of Ethiopia, Sudan, and Egypt is approximately four times that of the Rhine watershed, highlighting the crucial importance of the Nile River.

DISCHARGE AND SOIL LOSS CONSIDERATIONS

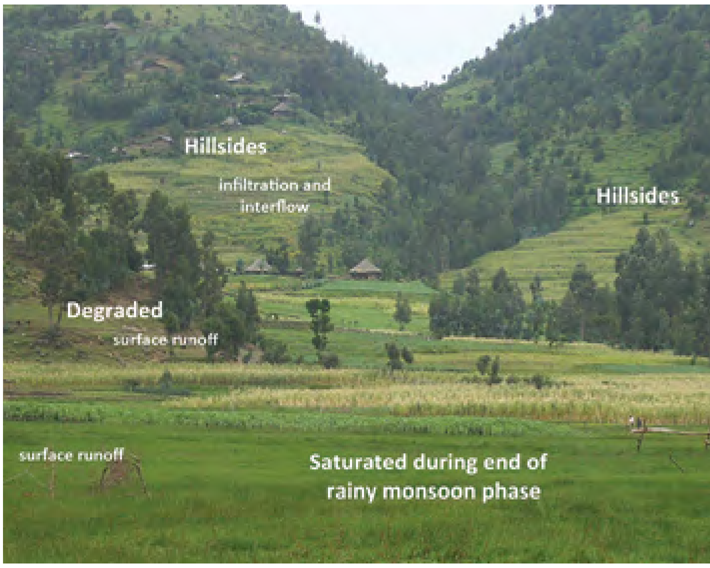
Because of the significance of the Ethiopian Highlands for downstream water supply, Egypt and Sudan are keen to gain a clearer understanding of future changes to rainfall and discharge in Ethiopia. Since climate models are notoriously imprecise, especially in the highlands of Ethiopia, there is no agreement among politicians and the public as to whether the climate in the Ethiopian Highlands is changing. Looking at the past fifty years, one of the conclusions of researchers who have examined the precipitation records from the various stations in the Nile Basin is that although there are strong annual variations, average precipitation levels have remained steady.

Similar statistical tests using available discharge data have found that the discharge in the Blue Nile Basin has generally increased during the wet monsoon period and decreased during the dry monsoon period. The annual stream flow has increased statistically at a few gauging stations. Sediment concentrations have also increased, but data are so scarce that statistical analysis is not possible.

Statistical methods cannot explain the change in river discharge and sediment concentrations. By using a deterministic model and by calibrating the model at the beginning and end of the same long-term data records, we can in principle see whether the relationship between rainfall and discharge and/or sediment concentration is altered. Changes in model parameters can then be related to changes in the watershed landscape. Several researchers have followed this procedure and, depending on the model used, found different underlying factors for the changes in river discharge. For example, Tesemma et al. (2010) and Tilahun et al. (2013a, 2013b) used the Parameter Efficient Distribute (PED) model and attributed the increase in discharge at the Ethiopian-Sudanese border to an increase in degraded shallow lands, which produce more surface runoff by saturation excess. Fitting the Soil Water Assessment Tool (SWAT) model to records of observed discharge and sediment concentrations of the past forty years at the Ethiopian-Sudanese border, Gebremicael et al. (2013) concluded that the changes in flow patterns (as observed from satellite images) were caused by a more than twofold increase in barren land and, to a lesser degree, by an increase in rainfed cropland and grassland coupled with the decrease in mainly wooded grassland, woodland, and natural forests. In the Gilgel Abay Basin at the headwaters of the Blue Nile in the Lake Tana Basin, a one-third decrease in low flows was probably related to increased use of water for irrigation and not to a decrease in forest cover that occurred at the same time. Finally, in the 364 km² Chemoga watershed in the southeastern part of the Blue Nile Basin, Bewket and Sterk (2005) attributed the decrease in low flow to multiple land use and degradation factors, including the destruction of natural vegetative covers, expansion of croplands, overgrazing, increased area under eucalyptus plantations, and greater water abstractions by growing human and livestock populations.

Thus all these studies agree that an increase in degraded land is related either to an increase in wet season flow or a decrease in dry season base flow. This accords with a conceptual hydrological framework in the PED model where infiltration capacity is many times greater than the infiltration rate of the soil as measured by several researchers. As a consequence, surface

FIGURE 1



Typical watershed in the Ethiopian Highlands. During the rainy part of the monsoon season, rainwater infiltrates the hillslopes, flowing into the valley as interflow and saturating the lowlands near the river, where any rainfall becomes surface runoff.

FIGURE 2

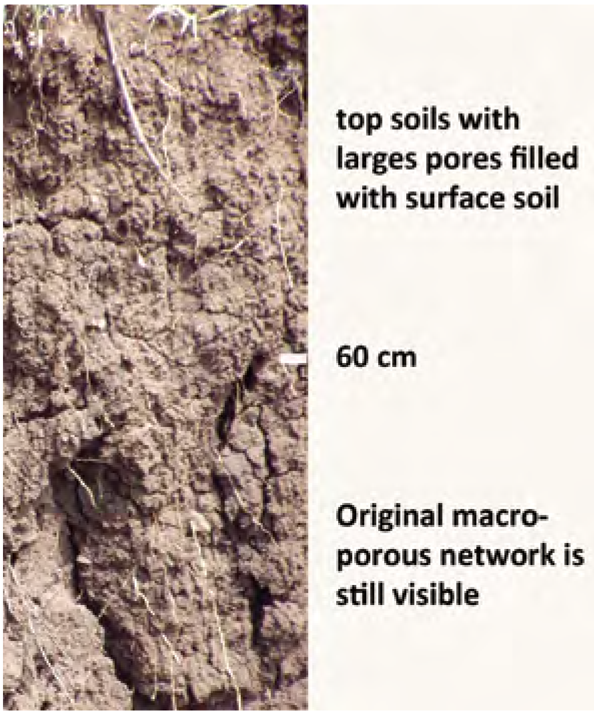
Degraded land in the Ethiopian Highlands. As soils are bare throughout the year, most rainfall during the rainy part of the monsoon season becomes runoff with an elevated sediment concentration.

runoff is generated both from locations where the soil becomes saturated during the rainstorm in the valley bottoms and soils that have a shallow depth and can store little rainwater. The rainfall on the remaining portion of the land that does not saturate infiltrates and then is slowly released to the stream. Figure 1, which shows the upper portion of a watershed in the Ethiopian Highlands, reflects this conceptual framework. The river, located in the lower part of the watershed, lies in an area that is saturated in the latter part of the wet monsoon season. The vegetation here is different from the rest of the hillside that remains unsaturated. Rainfall infiltrates the unsaturated hillslopes and then moves through the soil rather rapidly (because of the steep slope and relatively high soil permeability), through a process known as interflow. The water then flows down the slope, filling up the wetlands that deliver the water to the stream over a period of several days following the rain. The wetland itself drains much more slowly, because the slope is small so that it takes several months before the river stops flowing after the end of the rainy season. Figure 2 clearly shows the degraded areas where the shallow soil produces overland flow as well.

The process of land degradation is not well understood. There are two possible explanations: one explanation is that once the originally highly permeable soils are tilled and organic matter has decreased, raindrop impact loosens soil particles. These particles infiltrate into the soil with the water and block the flow paths in the soil. This is clearly shown in Figure 3, where the original, large pores are visible at a depth of 60 cm, but not above this level. The type of soil that fills the pores in this surface layer determines how much rainwater can still flow downwards. Another explanation is that erosion removes the topsoil, so that subsoil appears at the surface in areas where the soil is shallow. Thus, it seems reasonable to assume that when agricultural soils are tilled, the proportion of degraded land increases over time at the expense of the permeable hillsides that contain soils with high infiltration rates. The newly formed degraded land produces saturation excess runoff instead of being a source for interflow and base flow.

It is obvious that surface erosion only occurs in areas where there is overland flow and therefore the shallow soils over a hardpan are the prime source of sediment since the periodically saturated area in the bottom of the watershed is usually vegetated and not prone to erosion. An exception is when gullies form in the lowlands and the amount of soils lost is many times higher than in the uplands. Figure 4 shows one of these gullies. The people in the picture give a sense of scale and show its size.

FIGURE 3



A degraded soil profile: the original flow paths are only present in the lower part of the profile.

FIGURE 4

Large gully in a periodically saturated area in a watershed in the central Ethiopian Highlands

DISCHARGE AND SOIL LOSS PREDICTIONS

It is relatively easy to make a mathematical model from the conceptual hydrological model presented above by performing a simple water balance model for the three areas – the periodically saturated bottom lands, the degraded hillsides, and the permeable hillsides – where the model keeps track of the amount of water in the profile by adding the rainfall and subtracting the evaporation. When the profile gets really wet, the permeable hillslopes discharge the rainwater as subsurface flow. This is the water in the streams when it is not raining. Direct overland flow originates from the degraded hillsides and saturated bottom lands. Erosion is simulated as a function of the amount of overland flow (the greater the flow the greater the concentration) and a function of the amount of plowed soils on the degraded lands that are more easily eroded than soils with vegetation. Thus concentrations are greater in the beginning of the growing season than at the end for similar flows. Details of the model can be found in the references at the end of this article.

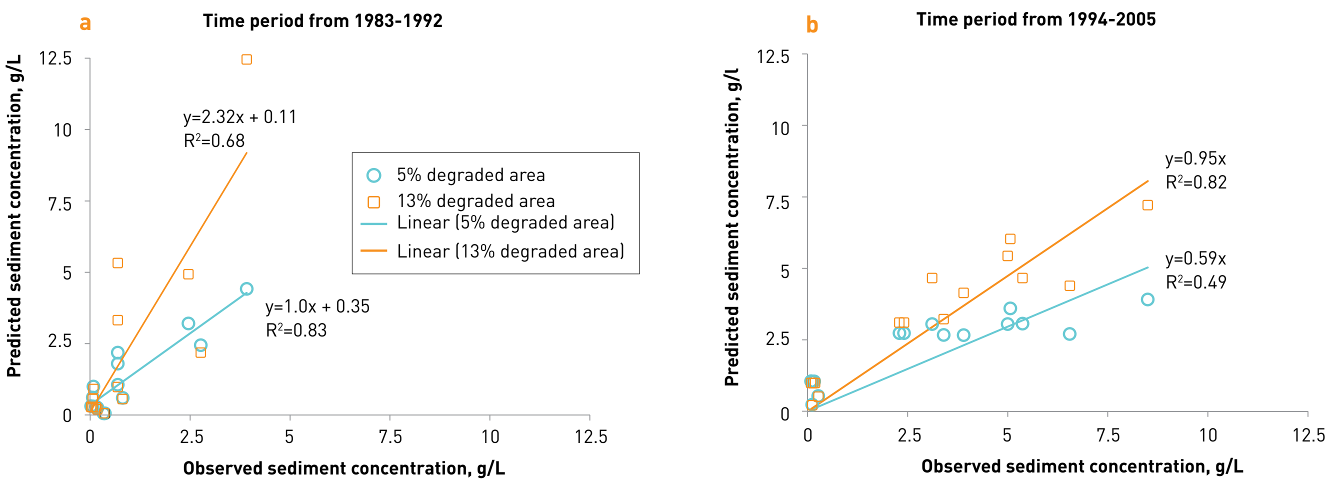
It was shown above that changes in discharge can be explained by the growing degradation of a portion of the landscape. In the next section, we will use the PED model to show how the increase in degraded areas affects sediment concentration in two watersheds for which we have limited sediment concentration data: the medium-sized 1,500 km^2 Gumara River watershed and the large 180,000 km^2 Blue Nile Basin. Only the portion of degraded hillside areas is adjusted after initial calibration, keeping the total area of the hillside the same. The sediment parameters themselves are not adjusted and thus the increase in sediment concentration with time is caused by a greater portion of surface runoff and soil loss originating from the degraded areas and to a lesser degree by a smaller amount of base and interflow from the remaining hillsides "diluting" the sediment concentrations. This is different from the many modeling studies that link the change in land cover to increased erosion.

GUMARA WATERSHED

Located east of Lake Tana in the Blue Nile Basin and originating on Guna Mountain at around 3,500 m asl, the Gumara River flows westward and joins Lake Tana about 35 km north of Bahir Dar. The river has a drainage area of about 1,500 km^2. Discharge and precipitation data for the period 1981-2005 show an average annual rainfall of 1,400 mm. Twenty-seven sediment concentration measurements were available for the period between 1982 and 2005. Although the Gumara watershed is large, it only has four weather stations.

By fitting the PED model to the discharge, we find that the degraded area increased from 5 percent in the 1980s to 13 percent in the 2000s. We then used the model to predict sediment concentration with the 5 percent degraded area in the 1980s and with the more recent 13 percent degraded areas. The predictions were quite good, as indicated by the 1:1 blue line between the predicted and observed sediment concentrations in Figure 5a where the data from the period of 1981-1992 are presented. The blue symbols are the predicted concentrations, assuming that 5 percent of the

FIGURE 5



Observed and predicted sediment concentration for the Gumara River in northwestern Ethiopia for the period (a) 1981-1992 and (b) 1994-2005. The orange symbols are for the 2000s when 13 percent of the watershed was degraded and the blue symbols and line are for the 1980s when 5 percent of the watershed was degraded.

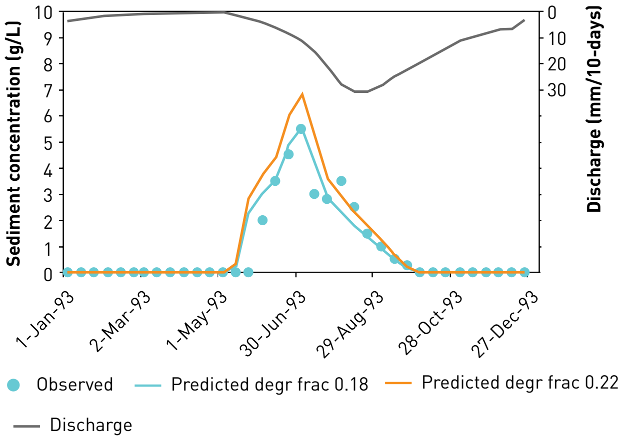
watershed is degraded. The orange symbols in this figure are obtained by using the present-day situation where 13 percent of the watershed is degraded. It clearly overpredicts the concentration in the earlier period. The lines represent the linear regression. Figure 5b shows the observed and predicted sediment concentration for the period 1994-2005. Here the 13 percent degraded area (orange symbols) is close to a 1:1 line while the 5 percent degraded area underpredicts the concentration significantly. Since we used a mathematical relationship between the input variables and the output, this demonstrates that the sediment concentrations have increased almost by a factor of two over the last twenty-five years.

BLUE NILE BASIN

We also have sediment concentration data for the Blue Nile at the Ethiopian-Sudanese border. The Blue Nile River, locally named the Abay, emanates from Lake Tana and covers a distance of nearly 850 km to the Ethiopian-Sudanese border, with a fall of 1,300 m and draining an area of 180,000 km^2. Lake Tana is located at 1,830 m asl with an annual average precipitation of nearly 1,400 mm and annual evaporation rates of 1,150 mm. Rainfall south of Lake Tana can reach 1,800-2,000 mm/year.

As in the Gumara watershed, we found that the best fit between predicted and observed discharge amounts was obtained by increasing the fraction of degraded area in the watershed from 12 percent in 1964 to 18 percent in 1993 and to 22 percent in 2003. In addition, like the results above, the PED model predictions provided a good fit for the ten-day-averaged sediment concentrations (solid blue line in Figure 6 for 1993). The black line is the observed discharge and it is clear that the sediment peak occurs before the discharge curve. By interchanging the calibrated degraded areas (i.e. using 22 percent for 2003), the observed sediment concentrations are overpredicted in 1993 (orange line in Figure 6). Thus, for the Blue Nile, sediment concentrations and discharge during the rainy phase of the monsoon season have increased over time.

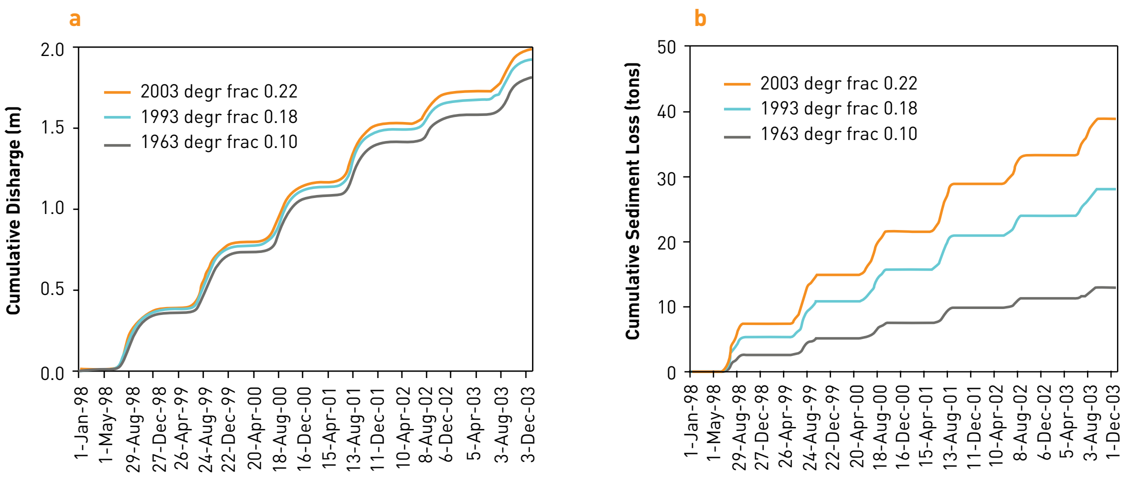
FIGURE 6



Observed (closed blue symbols) and predicted sediment (blue line) concentrations for the Blue Nile at El Diem on the Ethiopian-Sudanese border in 1993 when 18 percent of this watershed consisted of degraded hillsides. The orange line represents the predicted sediment concentrations by using a degraded area of 22 percent. The gray line is the discharge. Peak sediment concentration occurs before the discharge peak.

To illustrate the effect of the increasingly degraded areas on the discharge of the Blue Nile, we ran our model over the period 1964-2003 with the fraction of degraded areas changing in the Nile Basin in 1964 (0.12), 1993 (0.18) and 2003 (0.22) (Fig. 7a). Thus, an almost doubling of the degraded areas from 12 percent to 22 percent increases the annual discharge at El Diem from approximately from 30 cm/year to 33 cm/

FIGURE 7



Cumulative runoff (a) and sediment losses (b) for the Blue Nile at the border with Sudan for the period 1998-2003, assuming an increasing degradation of the landscape.

year averaged over the whole Blue Nile Basin. Although the increase in discharge is relatively small in the Blue Nile Basin, when we extrapolate this over the whole Nile Basin it would mean that there is significantly more water available in the Egyptian Nile than the 85 billion cubic meters originally mentioned in the 1959 treaty between Egypt and Sudan. The additional 10 percent of water available (equivalent to an extra 6 billion cubic meters) would be enough water to fulfill Ethiopian demand for irrigation water by developing irrigation schemes on approximately 3 percent of the watershed area.

For the sediment load, we assumed that the erosion per unit land surface of the three areas was not affected. As shown in Figure 7b, the cumulative sediment loads are increased by a factor of three from approximately 2 tons/ha/year (equivalent to 0.15 mm depth of spill per year) for the 10 percent degraded area to 6 tons/ha/year (equivalent to a 0.4 mm depth) for the 22 percent degraded area. The 6 tons is equal to the reported sediment loss at El Diem, but the 2 tons/ha/year in the 1960s at El Diem (assuming the same rainfall as in the 1990s) is probably not realistic. The trend is certainly correct if we consider the almost twofold increase in concentrations during the early part of the rainy season from 1972 to 2012 as shown in Gebremicael et al. (2013).

In summary, we find that landscape degradation has a significant short-term effect on the discharge and sediment load in a given period, while there was no significant trend in the precipitation pattern. This is not to say that climate change is not important in the long term. There have been several periods in the long streamflow record of the Nile when the flow increased significantly and this was probably not due to human influences. During the climatic optimum during the Holocene period, from 5000 BC to 3000 BC, when the temperatures were 1-2°C warmer than they are today, the Nile River had three times its present volume. Cold periods in Europe are related to low flows in the Nile.

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With its semi-arid climate, Spain is one of the most water-scarce countries in the E.U. Photo: Allie Caulfield, 2002.

16. Coming Changes in Global Water Policy

Ramon Llamas
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Scholars increasingly describe the period in which we live as the Anthropocene era, a term that highlights the growing impact – both positive and negative – of human activity and technological development on the environment. This short commentary argues that recent scientific and technological advances could help put an end to the sociopolitical conflicts that have plagued the Spanish water sector in recent decades. Inspired by the old Spanish proverb, "The devil knows more for being old than wise," this article is based on the author's extensive personal experience in the field of water resources.

With its semi-arid climate, Spain is one of the most water-scarce countries in the European Union (E.U.). It is therefore not surprising that in recent decades water has been the cause of frequent conflicts between regions and social groups. Water has become a major political weapon that has even influenced voting behavior. However, the increased attention paid to water has not resulted in better water management, as politicians are conditioned to think only until the next election and water management requires longer-term planning.

While solving water conflicts in Spain remains a complex task, scientific and technological advances over the last three decades provide grounds for optimism. Nonetheless, obstacles remain, firstly, because the current water management model through which the changes must be implemented is outdated. Moreover, public attitudes to water also need to change as many continue to believe that governments should fully subsidize all aspects of water management. In addition, some politicians turn water policy into a weapon to earn cheap votes.

Besides problems of water scarcity, Spain is experiencing a period of crisis in the labor market, the financial sector, the health and education sectors, and with regards to the balance of regional and centralized power. However, recent technological advances may offer solutions to the current problems in the domain of water:

Globalization and virtual water

Globalization has facilitated international trade and has shown the relevance of some new concepts such as virtual water and the water footprint.[1] The average daily water footprint of a Spanish citizen can roughly be broken down as follows: 2-3 liters for drinking, 200 liters for domestic and urban uses, 4,000 liters for daily food, and about 1,500 liters for industrial products and clothing. This amounts to an annual per capita water footprint of 2,100 cubic meters. A significant volume is imported in the form of food or livestock feed. The average annual precipitation in Spain is nearly 8,000 cubic meters per person – almost four times the correspondent water footprint.

However, precipitation figures are misleading because precipitation in Spain is very unevenly distributed in space and time. Erratic precipitation patterns, which have traditionally been a key cause of concern in arid and semi-arid countries, can and should be resolved today because globalization has given great impetus to the trade in virtual water. For example, despite its limited water resources, Spain is able to continue developing its livestock industry as farmers import virtual water in the form of cheap fodder and export virtual water in the form of meat products.

Intensification of groundwater use

The intensification of groundwater use over the last sixty years has profoundly changed water use patterns in arid and semi-arid regions. Globally, groundwater extraction has increased from 100 billion cubic meters to 1 trillion cubic meters (Margat and van der Gunn 2013). The intensification of groundwater use can lead to groundwater mining when the recharge is less than the amount extracted. It is a hotly debated topic that requires further research (Llamas 2004). In Spain, the intensification of groundwater use started in the 1950s. In the 1980s, annual groundwater extraction was estimated at 4-5 billion cubic meters. Today it has risen to around 7 billion cubic meters. The uncontrolled use of groundwater has had many impressive benefits, but has also created ecological problems and caused the decrease of groundwater levels. The government sought to address these problems through the 1985 Water Act, though results were very poor. Today, only 10-20 percent of wells are registered, an issue which the needs to be addressed.

Desalination

Major breakthroughs in chemical technology have reduced the cost of seawater desalination and the purification of urban and industrial wastewater. After the cancellation of the Ebro River Transfer Project, the water that would have been supplied to the Mediterranean coastal region through interbasin transfer was to be obtained through the operation of twenty large desalination plants. However, this plan failed and the new desalination plants are working at less than 20 percent of their capacity (see Ch. 4). Nonetheless, desalination is of key importance, particularly for the guaranteed supply of domestic water.

> While solving water conflicts in Spain remains a complex task, recent scientific and technological advances provide grounds for optimism.

Social media networks

The rapid development of information technology has revolutionized the way in which social networks function and develop, allowing for greater public participation in governance issues in general and water governance in particular, as required by the E.U. Water Framework Directive. The water sector, which is in need of far-reaching reform, should not be left behind while other governance structures are transformed.

Decision makers and managers in the water sector should be made aware of the technological and scientific advances discussed above. Some have suggested that the main political parties should make a Pact on Water to end the use of water as a political weapon. However, this is unlikely to happen in the short term.

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Endnotes

1 Virtual water is the water needed to produce any good or service. The water footprint of a group, or a person, or industrial process is the total amount of water that the group, person or industrial process uses to meet all their needs.

III. CRETE: THE MOSAIC APPROACH

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I resemble that Cretan centenarian whom I saw last year... "Grandpa," I asked him, "how has this long life of one hundred years seemed to you?" "Like a glass of cool water, my child," he replied, smiling. "Are you still thirsty, Grandpa?" And he, raising his bony arms, responded: "A curse on whoever is not thirsty."

NIKOS KAZANTZAKIS, IN A LETTER TO EDWIGE LEVI, 1947

If only I had the water of eternal life,
to give you a new soul,
to wake you just for a moment
so you could see, speak, and rejoice
in your whole dream
standing near, by your side.

YIANNIS RITSOS FROM THE CYCLE EPITAPHIOS

Introduction

Gail Holst-Warhaft
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On our first research trip to Greece in 2008, my colleague Tammo Steenhuis and I, together with Panayiotis Nektarios, a professor at the Agricultural University of Athens, visited the town of Neapolis in eastern Crete. We chose Neapolis as one of our sites because we had been told that the town had an exceptional mayor, a man concerned about the environment and one we could rely on to organize a town hall meeting for us so that we could meet a cross-section of people who would talk to us about the water situation in their region. We were an international group of scientists and others specializing in water, and we were impressed by Mayor Kastrinakis's efficiency and readiness to engage with us. After our first visit, he invited us to return in two years' time. By then he promised to organize a much larger meeting with representatives from *National Geographic*, the World Wildlife Fund and other national organizations concerned with water and the environment. He also offered to host a group of our students for a month while they learned what they could about the water situation in the environs of Neapolis.

In 2010, we took three Cornell graduate students who were working on water: Michael Bowes from Law, Margaret Kurth from Natural Resources, and Sheila Saia from Biological and Environmental Engineering. Mayor Kastrinakis, as he promised, had organized an impressive conference around the themes of *Water, Life and Culture* in Neapolis. The students, hosted by the mayor, stayed on and produced a report called *Water on the Brink: A Water Profile of Neapolis, Crete*,[1] which, as its name implies, concluded that the water situation in the town and surrounding agricultural lands was not critical, but that any small change in water use could tip the balance of water management into a crisis. Sheila Saia also published a summary of her research in *Revolve* magazine's special report *Water around the Mediterranean*, which was published in February 2012 (see Ch. 19).

In the summer of 2012, since Mayor Kastrinakis had been elected governor of the region of Lasithi, we decided to return to Crete and extend the research our students had begun in Neapolis to the entire eastern region of the island. Two articles in this case study (see Ch. 17 and 18) by Cathelijne Stoof and Diana Biller are the result of their stay. During our visits to Crete, Nikos Kastrinakis was enthusiastically involved in our project and without his help and hospitality the research would have been impossible. We include the text of a short talk Governor Kastrinakis gave in April 2013 in Athens at a conference we organized on water in the Mediterranean region (see Ch. 20).

1 This was an in-house publication by the Cornell Institute for European Studies (CIES), but GWP-Med produced a Greek version of the report so that it could be circulated on Crete. The report is available at http://cies.einaudi.cornell.edu/.

17. Tourism and Agriculture in Crete: Competing Claims on Water Resources and Potential Solutions

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FIGURE 1

The Lasithi Plateau, a high-mountain plateau in the east of Crete known for its windmills and agriculture. Photo: Cathelijne Stoof, 2012.

KEYWORDS: WATER SCARCITY, TOURISM, AGRICULTURE, INDUSTRY, CRETE, GREECE

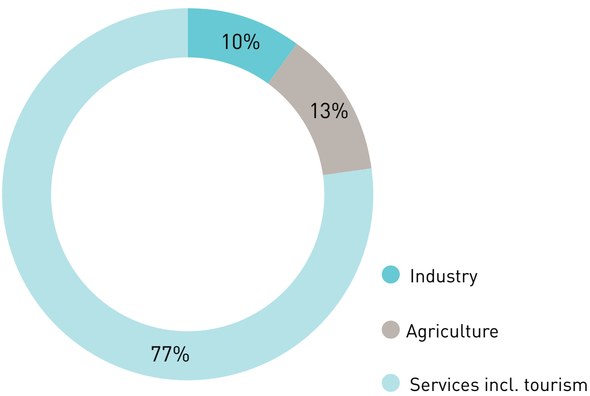
Abstract

The Mediterranean is a region where the availability of fresh water is limited, while being important for its agriculture and tourism facilities. We discuss competing claims on water resources and potential solutions using the example of Crete, Greece. After discussing water availability and comparing water use of the agriculture and tourism sectors, we present ways in which water can be conserved, and highlight promising ways to increase the availability of fresh water on the island. This can be of particular value given the expected decrease in rainfall and increase in tourist numbers.

THE ISLAND OF CRETE

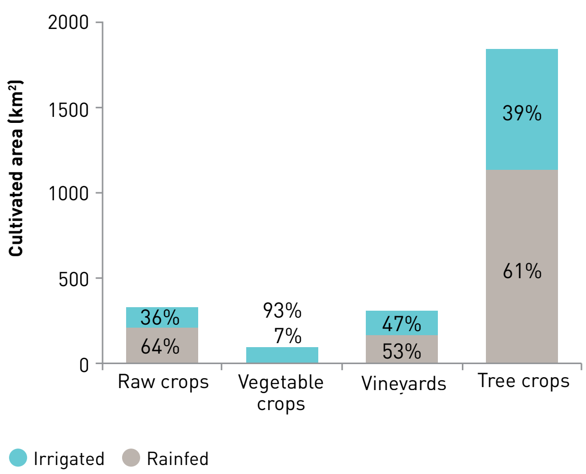
- Located in the Aegean Sea in the eastern Mediterranean
- Surface area: 8,336 km^2
- 2.8 million tourist arrivals annually, 20 percent of Greece's tourists
- Island is mountainous with relatively high rainfall
- Tourism is concentrated in the northern part of the island, agriculture in the south
- 40 percent of the island is cultivated, mostly tree crops (olives)
- Irrigated areal has doubled between 1961 and 2001 to 1,290 km^2

FIGURE 2



Contribution of agriculture, services (including tourism) and industry to the Gross Domestic Product of Crete. Source: Vardavas et al., 2005.

FIGURE 3



Areal and fraction of irrigated and rainfed cropland, specified by crop type. Source: Regional Governor of Crete, 2002, in Vardavas et al., 2005.

INTRODUCTION

The pressure of humans and climate on water resources is increasing around the world, and the Mediterranean is no exception. The Mediterranean has traditionally been a region where the availability of fresh water is limited, while at the same time being important for its agricultural production and tourism facilities (Fig. 2). These two main production sectors put strain on water supplies in a region where water availability can be severely limited in parts of the year. An expected decrease in rainfall and increase in air temperatures because of climate change will probably aggravate the situation.

To overcome this limited water availability without limiting growth in the region requires creative ways to limit the use of fresh water, increase water storage on or under the land, and increase the amount of fresh water that can be used in a sustainable way (see Ch. 12). This is not only important for sustaining current livelihoods, activities and production in the region, but also for the environment. Water conservation and increasing water storage on land prevents depletion of groundwater reserves, which has multiple benefits as this 1) increases the water buffer in case of drought; 2) increases environmental flows in streams, which is favorable for both in- and near-stream flora and fauna; and 3) pushes down the fresh/saltwater boundary, which decreases the risk of groundwater salinization. All these positive effects help comply with the E.U. Water Framework Directive, which requires E.U. member states to take care that all water bodies (above and below ground) have good water quality and quantity. In this chapter, we focus on the island of Crete, the largest of the Greek islands. While Crete is probably best known for its cultural heritage and archaeology and is thus a tourist destination, it is the agriculture sector that uses by far the most fresh water on the island (Fig. 7). Despite a high average per capita water availability (5,800 cubic meters in 2000), development is limited by dwindling water availability. Irrigation of agricultural fields is common (Fig. 3), yet because of a lack of freshwater resources, only part of the irrigation demand is met.

Several previous studies already highlighted that measures should be taken to limit water demand and find alternative ways to tap the island's resources in a sustainable way. Here, we review the climatic and hydrogeological situation of Crete and present ways in which water can be conserved in the island's agriculture and tourism sectors. We conclude by highlighting promising ways of increasing freshwater availability on the island, something that can be of particular value given the expected decrease in rainfall and increase in tourist numbers.

WATER AVAILABILITY

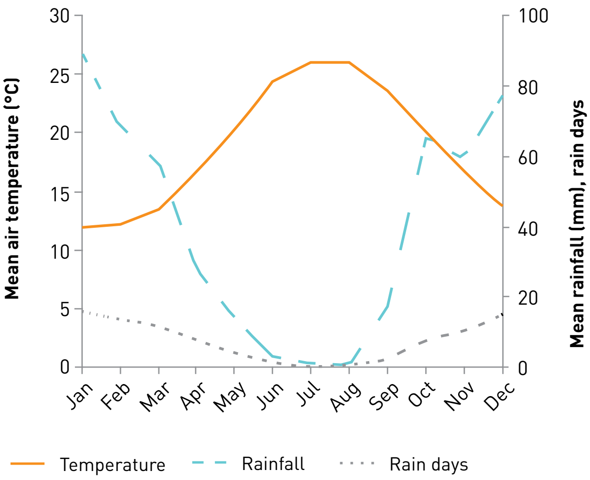
Rainfall is unevenly distributed

Water scarcity issues on Crete occur mainly because of the uneven spatial and temporal distribution of rainfall. The average rainfall on Crete (1,000 mm) is relatively high

FIGURE 6

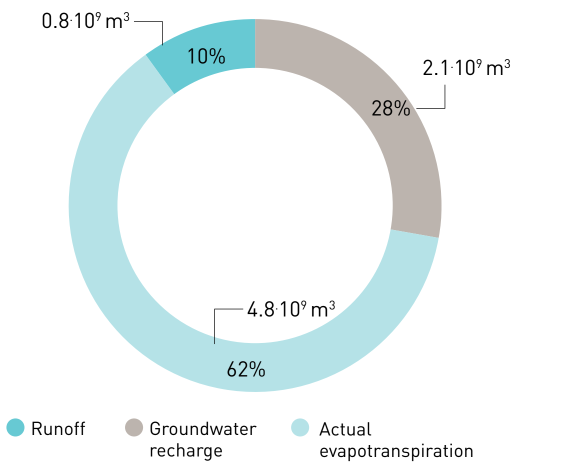
The Messara Basin, where years of overexploitation of groundwater resources for crop irrigation dramatically lowered the groundwater table.
Photo: Cathelijne Stoof, 2012.

FIGURE 4



Seasonal distribution of air temperature, rainfall and the number of rain days. Source: Hellenic National Meteorological Service.

FIGURE 5



Average partitioning of total rainfall into evapotranspiration, runoff and groundwater recharge. Source: Regional Governor of Crete, 2002, in Vardavas et al., 2005.

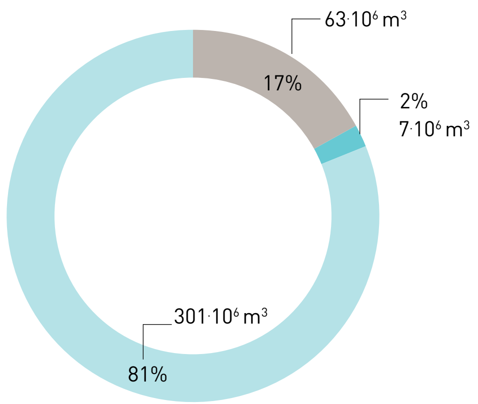
for the region, but this rainfall is unevenly distributed in time and space. The west receives almost 300 mm more rainfall per year than the east, and there is also a strong increase of rainfall with elevation: the plains receive 600 mm on average and the mountains up to 2,000 mm. Most precipitation is concentrated in winter, with summers receiving practically no rainfall (Fig. 4). The majority of Cretan rainfall is consumed by evapotranspiration (about 60 percent), and about 10 percent flows to the sea in streams that carry water in winter and are dry in the summer. The remaining 30 percent recharges the groundwater, which is the predominant source of fresh water on the island (Fig. 5).

Groundwater occurrence and use

Most of the groundwater on the island is found in karstic aquifers[1] that are discharged by springs, both on the island itself and in the sea. Temperature mapping of seawater shows that there are many large springs that discharge directly into the sea. Little can be done about large springs discharging into the sea before their water can be used and, as a result, only a fifth of the total groundwater recharge on Crete is used – a mere 5 percent of total precipitation inputs (Vardavas et al. 2005). While most of the water in underground channels is lost to the sea, in some areas the geology is favorable in that it prevents water from leaving to the sea directly. A series of faults parallel to the coast near the city of Chania hold water back and form an aquifer that can be used for irrigation before the water is lost to the sea. Because of this, water availability in Chania is reliable throughout the year.

A smaller fraction of Crete's groundwater resources occur in the plains. Agricultural activity on these plains is intense, and many of the underlying aquifers are overexploited. The Messara Basin (Fig. 6) is a well-reported example of this. With an area of 398 km^2 it is the

FIGURE 7



Crete water consumption in the year 2000. Source: Vardavas et al., 2005.

largest and most productive agricultural valley on Crete. Irrigated agriculture in the Messara Basin started in the 1980s when installation of groundwater pumps provided a means to switch from rainfed olive production to drip-irrigated cultivation. This resulted in a rise in production and a severe drop in the groundwater table, with reports of the drop ranging from 20 m to 45 m (Croke et al., 2000; Kritsotakis and Tsanis, 2009), causing saltwater intrusion in coastal areas.

Agriculture is a major water consumer not only in the Messara Basin, but also on the rest of the island. While this sector accounts for only 13 percent of Crete's gross domestic product (GDP), it consumes 81 percent of the total water supplies on the island, with 301 million cubic meters of water used each year. And although tourism is commonly viewed as a high water consumer, domestic water use, including by tourists, consumes only 17 percent of total water (63 million cubic meters), while contributing a GDP share of 77 percent (Fig. 2 and 7).

WATER CONSERVATION

Agriculture: drought-adapted vs. irrigated crops

Farmers in Crete have grown drought-tolerant crops such as grapes and olives since ancient times. When these water-efficient crops are replaced by other crops such as kiwifruit and oranges water shortages occur: kiwifruit and oranges are not drought-resistant and need to be irrigated during the time that the rainfall is less than the evaporation. These fruit trees therefore evaporate at the potential year-round rate, which averages approximately 4 mm/day or in the range

FIGURE 8

Drip-irrigated olive trees in the Messara Basin. Photo: Cathelijne Stoof, 2012.

of 1.4 m/year. Since rainfall on Crete is in the order of 1,000 mm or 1 m/year, an additional 0.4 m of water needs to be drawn from other sources – usually groundwater. It is unlikely that natural recharge (from rainfall) can make up for this loss and one can expect a groundwater decline of 0.5-2 m/year depending on the porosity of the aquifer and the density of the irrigation systems. Olives and grapes do not need to be irrigated and can therefore be grown with the available rainfall. Even when olives are irrigated, they do not evaporate at the potential rate but at a reduced rate of 3 mm/day at the most or in the order of 1-1.1 m/year, which is close to the average annual rainfall. In this case, no large drawdown from the aquifer is expected provided that efficient irrigation systems are used that deliver water to trees only (Fig. 8). Although the above calculations are greatly simplified, more complex models will reach nearly the same conclusions.

Improving irrigation efficiency

There is currently a broad debate about whether improvements in irrigation efficiency lead to a greater areal of irrigable land (see Ch. 12). The answer might be surprising and depends on the fate of the excess irrigation water, i.e. the amount of water that is not consumed by plants or evaporated. If the excess irrigation water is lost to the sea and is not reused downstream, greater irrigation efficiency will increase the volume of water available for irrigation. However, if the excess irrigation water is reused (for example when it leaches down and recharges the same aquifer from which irrigation water is pumped) greater efficiency will not result in more water becoming available to irrigate additional land (Fig. 9). It should be noted that direct evaporation of sprinkler irrigation water during the day instead of during the night forms a loss and will reduce the groundwater recharge. To conserve water when sprinkler systems are used, it is therefore best to avoid the heat of the day when applying irrigation.

Tourism and city planning

With the influx of tourists on Crete peaking during the hot, dry summer months, it is not surprising that water use and thus water savings in the tourism industry catch the eye of many. There are various simple ways to save water in the tourist industry, which are interestingly not only applicable in this industry but also beyond. Measures to save water or promote infiltration of rainfall include increasing water storage and decreasing water use (Fig. 10).

FIGURE 9

EXCESS IRRIGATION WATER USED DOWNSTREAM?

YES – Greater irrigaton efficiency will not increase volume of water available for irrigation

NO – Greater irrigation efficiency will increase volume of water available for irrigation

Effects of increased irrigation efficiency on water availability depending on the fate of excess irrigation water.

FIGURE 10

WATER SAVINGS

- Rainwater harvesting from roofs, grey water use in toilets and for irrigation
- Use of drought-tolerant (native) species in gardens, parks and golf courses
- Stimulate reuse of towels and bed linen
- In golf course construction, use narrower fairways and greens, and select appropriate soil material
- Use of water-saving toilets, showerheads, faucets

Overview of possible water-saving measures in the tourism sector and in other city planning.

Rainwater harvesting and use of drought-tolerant species

Rainwater harvesting is an ancient method that was once used on Crete and in the rest of the Mediterranean. Until the 1950s, many houses in rural areas had cisterns (underground tanks) to store harvested rainwater, but this practice was gradually abandoned after the introduction of municipal water supply systems. Municipal water is cheaper than the repair and/or maintenance of the cisterns. Cisterns are therefore still commonly found around Crete but often in a state of disrepair (see Ch. 19). This is unfortunate in areas with limited rainfall or limited water availability, as rainwater-harvesting structures facilitate storage of the water until it is needed in times of water shortage. They thereby increase the proportion of rainfall that can be utilized before it is evaporated or lost to the sea, and offer a simple and valuable source of water in dry periods.

One area of Crete where rainwater harvesting is recognized by farmers on a large scale is in the east. Around Ierapetra, rainwater harvested from the roofs of greenhouses is stored in underground tanks on-site and used as an additional water supply in flower production (Fig. 11). Without this additional source of water, flower production in this area would not be possible at this scale. The benefits of rainwater harvesting are not limited to the agriculture sector; it can also be applied in other sectors. Water harvested from roofs of hotels and other large buildings during wet periods can be used during dry periods to flush toilets and water lawns and gardens. Combined with water-wise design and the use of drought-tolerant species, extraction of water for irrigation of gardens and parks can be considerably reduced.

Water-wise golf course management

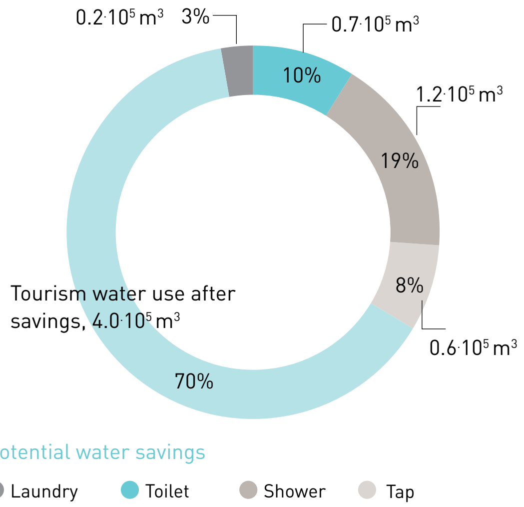
In water-scarce regions, golf may be the tourist activity that is most often associated with high water use because of the contrast between green golf courses and the surrounding dry landscape. Golf courses do require a lot of water for irrigation. An 18-hole golf course covering 54 ha requires roughly 0.5 million cubic meters/year of water, assuming potential evaporation of 5 mm/day during summer (six months) and evaporation in winter being compensated by rainfall. There are various ways of offsetting this irrigation water requirement, and many of them commonly used by golf industry professionals. Golf courses can limit freshwater usage both during and after construction.

During construction, future water use can be limited, for instance, by reducing the size of playing surfaces, using soil mixtures and

FIGURE 11

Greenhouse near Ierapetra. Photo: Cathelijne Stoof, 2012.

FIGURE 12



Potential water savings in the tourism industry amounting to 40 percent (2.7 million cubic meters) of total tourism water use. Values are based on an average of 2.8 million tourists per year, an average stay of eight days with a water use of 300 liters per day per guest, an average water use for one laundry load of 36 liters per guest, and Table 1.

amendments that can hold water optimally, and selecting drought-tolerant grass species that can cope in dry conditions.

Measures that can be taken after construction include precision irrigation based on soil moisture, prevention of soil water repellency (a common phenomenon hampering infiltration of water), using grey water from rainwater harvesting or recycled wastewater for irrigation, and suspending irrigation when water is not available.

Reuse of towels and bed linen

Hotels around the world have been inviting their guests to go green by giving them the option of using their towels and bed sheets more than once. This is usually done with a system of message cards on night tables and in bathrooms, which make guests aware of the importance of saving water, and indicate how the guest can help. This is based on the concept that at home towels are often used more than once, and bed linen is certainly not changed every day. Surprisingly, this type of water savings is not common in hotels on Crete. It may be a strange idea for Cretans that tourists are willing to use a towel or their bed linen twice, but the success of towel and linen reuse programs in the tourism industry elsewhere shows that tourists not only accept it; some even expect it.

The water-saving benefits of towel and linen reuse programs are small compared to water savings in the agriculture sector. If 50 percent of guests on Crete would choose to have linens and towels replaced every other day, roughly 0.2 million cubic meters water could be saved each year (Fig. 12). This is 3 percent of the total volume of water used by tourists, and 0.05 percent of total annual water use on the island. It is also equal to the water use of one half of an 18-hole golf course. While these water savings are small, such a program would provide additional environmental and economic benefits, including improved water quality because of the reduced use of bleach and other detergents, reduced energy use and cleaning costs, and increased awareness about water scarcity.

Use of water-saving toilets, showerheads and faucets

The installation of water-saving toilets, showerheads and taps is another simple way to reduce water demand in the tourist sector. Modern water-saving toilets or dual-flush systems use up to five times less water than older types, and economic showerheads and taps can use four to six times less water per minute than conventional types (Table 1).

A rough calculation of potential water savings if all tourist facilities on Crete had these water-saving devices installed shows that total bathroom water savings (2.5 million cubic meters for toilets, showers, and taps together) would amount to 37 percent of total water use in the tourist sector (Fig. 12), and 0.7 percent of the total annual water used on the island. Naturally, the exact savings depend on the systems currently in use

TABLE 1

Use		Water use per flush or minute			Frequency (per day)	Total water saving (L/day)
		Before	After	Saving		
Toilet	Liquid only	12 L/flush	1 L/flush	11 L/flush	4 x	44
	Incl. solids	12 L/flush	6 L/flush	6 L/flush	2 x	12
Shower		13 L/min	7 L/min	6 L/min	5 min	30
Tap		5 L/min	2.5 L/min	2.5 L/min	10 min	25

Source: Water use of toilets, showers and taps are taken from Silva-Afonso and Pimentel-Rodrigues (2008) and Gössling et al. (2012). The frequency is assumed and the total water savings are calculated by multiplying the saving per item with its assumed frequency of occurrence.

and frequency of use. Where older systems are in place that have higher water consumption, or when showers and taps are used more frequently, the savings can be considerably greater. The same applies when installation of these water-saving devices is extended to public buildings and the private sector. Because of the reduction in water costs, installation of these water-saving devices can be repaid quickly.

Water savings in hotels versus golf courses and agriculture

In contrast to the common perception, tourists do not account for a large portion of water demand. Based on a water use of 300 liters per day, all tourists on Crete use just 6.7 million cubic meters, which is a fraction of the amount used for irrigation (301 million cubic meters). Tourism's water use is comparable to the irrigation requirement of 9 km^2 of cropland (less than 1 percent of total irrigated land on Crete) that is irrigated for half of the year.

Although every drop counts in water conservation, water savings in the agriculture sector (including on golf courses, gardens and parks) have greater potential to reduce Crete's water demand than water savings in the tourist sector. Yet, in parts of the island where there is limited water availability in the region where the hotels are located, water savings in tourism could help reduce water shortages.

INCREASING WATER AVAILABILITY

Because the majority of Crete's freshwater resources are lost to the sea before they can be used, water availability cannot only be increased by reducing water use, but also by developing creative ways of maximizing the use of natural winter rainfall (Fig. 13).

From a range of possible water sources, Crete's fresh water is currently being tapped from springs, aboveground reservoirs (dams) and underground wells. Because of the karst geology, groundwater reserves on much of the island are very hard to predict, which makes the uncertainty of reaching fresh water when drilling a well high.

Infiltration in selected deposits for future withdrawal

Because rainfall in winter is high, a simple way of increasing freshwater resources is to promote storage of this winter rainfall. In addition to rainwater harvesting from roofs, this can be done by slowing water in natural streams, or by letting part of the winter streamflow infiltrate locally. On Crete, this can be done in 1) alluvial deposits, 2) gypsum deposits in marl areas, and 3) limestone deposits overlying marls. Recharge of winter rainfall in these deposits can then be pumped up during the drier summer months, and provide a more reliable source of water than drilling wells in limestone areas. Unlike water storage in aboveground dams that have high evaporative losses, a major benefit of underground water storage is that there is no evaporative loss. The rate of return for water stored underground is therefore greater than for water stored in aboveground dams.

FIGURE 13

FRESHWATER RESOURCES

1- Springs
2- Dams
3- Wells
4- Rainwater
a) from impermeable surfaces
b) by promoting infiltration of streamflow into soil by slowing water in streams or by letting part of the stream in winter infiltrate locally into alluvia and dolines.
5- Tapping water from underground streams
6- Desalination

Potential freshwater resources.

Tapping of coastal aquifers using underground dams

Another source of fresh water is found in riverbeds flowing to the sea. While most streams in summer are dry at the surface, water is discharged to the sea below ground. In areas where the coastal aquifer is underlain by impermeable bedrock, this water can be tapped by constructing an underground dam that prevents fresh water from being lost to the sea. This underground dam basically consists of a subsurface wall that retains fresh water upstream, which can be pumped to the surface using a set of wells that can tap water from the aquifer without the risk of saltwater intrusion.

The concept of water storage behind subsurface dams is very old, and these types of dams are used to increase yield from coastal aquifers around the world, from Ethiopia to India and from Turkey to Japan. The suitability of a coastal aquifer for underground dam construction depends on the hydrogeological conditions. When conditions are right, there are multiple benefits to storing water underground, including much lower or no evaporative losses and lower risk of pollution. In addition, storage capacity is not affected by the gradual filling up of the reservoir and underground reservoirs take up less space and are considerably cheaper than dams. They therefore have the potential to provide a cost-effective way of increasing local water availability, with lower social, visual, and environmental impacts.

The National Technical University of Athens recently studied whether underground dams could be used to tap coastal aquifers on Crete and found that underground dams can increase water resource management efficiency, while preventing saltwater intrusion. Hydrogeological conditions are favorable in Lasithi, and most likely elsewhere on the island. Given the multiple economic and environmental advantages of underground water storage, we highly recommend further study of this promising technique to increase the availability of fresh water on Crete.

Desalination and wastewater reuse

Some of the few rainfall-independent water sources are desalination of sea- or brackish water and the use of recycled wastewater. In Israel these techniques are combined by first using desalinated seawater in households and then using all household effluent to irrigate crops. The cost of clean water derived from desalination is greater than from conventional sources such as groundwater or surface water, and is therefore only implemented when there are insufficient freshwater sources, which is the case in semi-arid to arid regions that have a large population. The cost of desalination has come down over recent years and the most efficient plants can desalinate one cubic meter of water at $0.5 to $1. For an average person living in the U.S., who uses around 400 liters of water per day, the cost of desalination would be just over $100 per person per year. Since Europeans are much more efficient with water, the cost of desalination would be around $50 or less per person per year on Crete. Other costs associated with the delivery would increase the price.

With other Greek and Turkish islands in the Mediterranean using desalination to produce fresh water, the question is whether Crete should also resort to desalination. Compared to other areas of the Mediterranean, Crete has relatively high rainfall. Most of this water flows as groundwater to the sea, except in a few places like on the north coast near Chania. As explained earlier, this area has abundant water because of its favorable geology, which prevents underground water flow to the sea. By replacing some of this fresh groundwater with wastewater that can irrigate the same acreage, the 'displaced' fresh water can be used elsewhere on the island where there is water shortage. Naturally, this is only sustainable if the environmental and energy costs of transporting this water are less than those associated with desalination.

OUTLOOK

The scarcity of water that Crete experiences in the summer months and the depletion of groundwater resources in agricultural areas around the island indicate that with the current land use, industry and tourism practices, water scarcity is an important issue that needs to be tackled in order to manage the island's water resources sustainably. Given the expected effects of climate change, water scarcity will most likely increase in the future. Current climate scenarios for the next 90-100 years predict reductions in precipitation and increases in temperature on the island, leading to a substantial reduction in water availability. In addition, the area of the island affected by drought is set to increase. Along with this predicted reduction in water availability, there is the expected increase in tourist arrivals and a potential increase in irrigated area. Reducing water demand and optimizing water availability will therefore become increasingly important in the future.

CONCLUSION

In contrast to many water-scarce regions around the world, average per capita water availability on Crete is relatively high, particularly because of high winter rainfall in the mountain areas. On average, therefore, Crete does not have a water problem. However, as most of the water is evaporated or flows away before it can be used, water availability is low during warm dry summers when tourism is at its peak and agriculture requires most irrigation water.

We highlighted several promising methods to save water in the agriculture and tourism sectors, including: reducing water demand; stimulating water reuse in the tourism sector and in city planning; selecting crops with low water requirement; and either using smart irrigation planning or avoiding irrigation altogether. Although public opinion often points to tourism as the main water user, we showed that water demand in the agriculture sector is much greater and that this is also the area where most water can be saved. Yet, while water savings in the tourism sector may be small they can be achieved through simple measures, while at the same time increasing awareness about water scarcity, and increasing revenues. Naturally, these water-saving methods are not only applicable to the island of Crete.

Because rainfall is actually quite high on Crete, we showed that water availability can not only be increased by saving water, but also by increasing water storage before it runs off, and by tapping underground water flows before they reach the sea. Given that both can be done at much lower cost than, for instance, the construction of large reservoirs, these are promising, low-cost alternatives to increase the availability of this natural resource.

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ENDNOTES

1. Karst is limestone with large caves and underground channels where water flows. Aquifers are underground water reserves. The location of aquifers in karst areas is very unpredictable because of the unpredictable nature of the location of the channels and the caves.

The Lasithi Plateau. Photo: Diana Biller, 2012.

Abstract

This paper discusses the author's year-long experiences as a law student working on problems in Mediterranean water law and management. Beginning with an initiative to create a model water code for the region, and cumulating in a short research trip to Crete, this year raised questions relating to interdisciplinary work, participation as an American law student and expertise. While this paper will include discussion of legal research observations made during this time, its primary focus will be reflexive.

KEYWORDS: WATER SCARCITY, WATER LAW, STUDENT ENGAGEMENT, INTERDISCIPLINARY STUDY, CRETE, EUROPEAN UNION

18. A Law Student's Year in Mediterranean Waters

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Introduction

My first serious engagement with water law in the Mediterranean occurred, incongruously, in the dreary winter of Ithaca, New York. As a second-year student at Cornell Law School I enrolled in a water law clinic, which fostered hands-on projects, steered by the students themselves, spanning several geographical regions. Several students, for example, worked on the highly contentious question of hydrofracking in New York State, while the group I joined focused on water law in the Mediterranean and the Middle East.

After I expressed an interest in water scarcity, the clinic's professor Keith Porter introduced me to the vibrant team of academics at Cornell University working more broadly on water issues. They were in the process of organizing an interdisciplinary and international conference in Ithaca on water scarcity in the Mediterranean and Middle East. They suggested that a team from the clinic work on a joint project that could be presented at a pre-conference panel, allowing the law students to engage with scholars from around the world, many of whom have contributed to this book.

Four students (myself, Natasha Bhushan, Tamaron Greene and Matt Danforth) came together to focus on water law in the Mediterranean. The first major problem we faced was indeed a serious (and general) one: what could four American law students contribute to a question hinging on at least two separate areas we knew next to nothing about? Problems in water law are particularly complicated: not only do they usually involve several layers of law (from international law to municipal law, frequently containing the legacies of multiple, not always complimentary, historical periods), they also require some basic knowledge of hydrology (for example, in order to make sense of differences between regulations on groundwater and regulations on surface water, you do first need to know what groundwater is).

In the end, we decided to investigate the potential contribution of a model water code to problems of water scarcity. Model Codes are akin to legal cookbooks: their primary goal is not uniformity, but rather to serve as a tool for legal reform by increasing accessibility to legal knowledge and to provide a template which a state or country may adapt to suit their own environment (physical, cultural, political, etc.). Acknowledging that we did not have the expertise to outline the content of such a code, we instead attempted to deduce what the guiding principles of such a code should be. We highlighted the equitable allocation and sustainable use of scarce resources, and pulled elements from international law (from, for example, the Aarhus Convention).

The experience of thinking through what a model code could look like and what purposes it could serve emphasized two interconnecting questions, especially important for a team of law students working in a different country, but also, I think, relevant to work on water policy more generally: the problem of expertise, and the necessity of engaging across disciplines and professions. These themes were solidified during the next chapter of my engagement with water law: an interdisciplinary water research trip to the island of Crete.

Studying water law in Crete was a complicated task, largely because a lack of sufficient language skills to engage with the text of the laws, and also because it was extensively layered. What follows is a sketch as I was able to glean it, relying largely on sources in English.

Greek water law: still confused, but improving?

The state of water law in Greece is historically quite tangled, although recent changes have improved the situation somewhat. The situation, however, remains confusing (especially for non-experts). This is especially true in some key areas: for example, issues of water quantity in groundwater remain semi-linked to property interests even though property owners no longer have the automatic right to use the groundwater below their land since 1987.

The 1940 Greek Civil Code treats surface and groundwater in separate articles (art. 967, 954, 1027).[1] While surface waters were designated an "object of common use" and given a set order of water-use priority, groundwater was left to the use of the private landowner (or renter). The landowner could use the groundwater underneath his land to the extent that it did not significantly decrease the water supply of nearby villages.

A 1965 Sanitary Regulation introduced disposal permits for certain types of effluents; the permits were issued at the prefecture level.

The 1987 Framework Water Law (Law 1739/87 for the Management of Water Resources) created major reform in Greek water management. It introduced a permit system for the use of both surface and groundwater, detaching groundwater use from land ownership (to a certain extent: well permits are only issued for those wells located on privately owned land). Permits were at first issued by multiple authorities, a confusing state of affairs, but in 2003 regions became the sole authorities capable of issuing permits. Permits, which are issued for a period of ten years, define how much water may be used and the conditions of use (Tsakiris et al. 2005). However, as Kampa and Bressers note, "to date, permits are still issued without taking account of the interconnection between surface and groundwater or of water ecosystem issues" (2008: 487).

The Framework Law also introduced a permit requirement for the construction of public water works. Ultimately, many important implementing documents were never drafted or adopted, and it was almost two decades before a 2005 Common

Ministerial Decision implemented permitting requirements.

A similar delay in implementation existed for the broader Framework Law. As Tsakiris et al. note:

> ...[T]here are some points that led to the unsuccessful implementation of the Law 1739/87, such as: (i) the multiple distribution of authorities to different Ministries which has hampered integrated actions; (ii) the fact that water resources management was not incorporated in the environmental policy; and (iii) the allocation of water quality and quantity issues within the same area to different authorities (2005: 51).

Although the Water Framework Law was the guiding water management legislation for fifteen years, it was handicapped by incomplete implementation. Serious water quantity issues continued. Particularly troubling are continuing groundwater quantity concerns. Land owners continue to overexploit groundwater below their property. Another major problem, highlighted by Kampa and Bressers (Ibid.), is that permits are only issued for *new* water use. This allows water uses that existed before 1987 to continue without permission, creating a large gap in legislative coverage.

Other problems with the 1987 law include lack of integrated management, which should be remedied by the Water Framework Directive, and inadequately funded operational authorities. Further, it only focused on water quantity issues. Water quality was governed by the 1986 Law on the Protection of the Environment. A number of other semi-overlapping directives and decrees, both from before and after the passage of the 1987 Framework Law, made the situation increasingly complex, especially once E.U. law began to be implemented.

The 2003 law integrating the E.U. Water Framework Directive at the national level, the Law on the Protection and Management of Water (Law 3199), required the creation of a significant new administrative structure. Much of this structure should aid coordination. For example, the 2003 law created a Ministerial National Water Committee, which is tasked with creating and monitoring water policy, and brings together several different national authorities. The law also creates Regional Water Directorates in each administrative region, which are in charge of the river basins in their regions. If a basin crosses regions, the directorates may either act together or the National Water Committee may designate one directorate to be the lead. The directorates report annually to a Central Water Agency, also created by the 2003 law.

View from the island of Spinalonga. Photo: Diana Biller, 2012.

The 2003 law also covers both water quantity and quality. In many important respects, it is a major step forward in terms of coordination, streamlining and generally dispelling confusion. Unfortunately, its implementation was seriously delayed. Further, according to Kampa and Bressers, "[f]ormal policies to achieve more integration now seem to be largely in place but a sufficiently favourable institutional context is still missing" (Ibid).

Model Codes are akin to legal cookbooks: their primary goal is not uniformity, but rather to provide a template which a state or country may adapt to suit their own environment.

Cretan water law

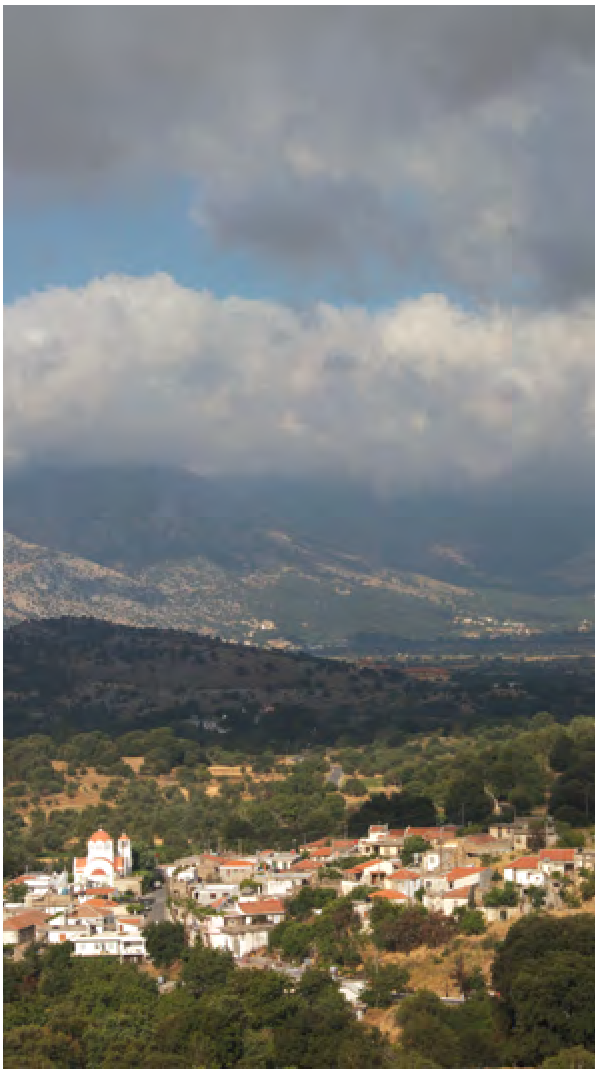
Crete, besides being governed by the legal structure briefly summarized above, has also delegated water provision use and sanitation legislation to its municipalities. These local regulations can be quite successful, but there is also significant risk attached. As the Cornell research team concluded about the Municipality of Neapolis, "The Local regulations, governance and management (which are controlled by the council headed by the Mayor) has thus far been more than satisfactory, indeed for such an arid region it should be complimented. This is not to say that if it were to be managed in a different way and the local legislation either varied or ignored that there would not be problems in the future" (Saia et al. 2011: 34-35).

For farmers, agricultural water may either be provided by the municipality or by a TOEB, a local farmers irrigation organization. TOEBs are private, non-profit organizations supervised by the Ministry of Agriculture through the regional unit level. They were established in 1958, and "[t]heir objective is to improve the conditions of the member farms, which are located within their authority area, regarding water supply" (Katsikides and Dörflinger 2005: 114).

Researchers report similar legal problems at the Cretan level as they do at the national one: coordination problems, too many different authorities, lack of funding (Chartzoulakis and Bertaki 2010). Most of these problems were confirmed by my own observations.

In addition to my own problems of limited expertise in researching the law, our team also had to learn to navigate between disciplines, particularly to find a language to communicate between law and engineering. This is seemingly an important goal far beyond our own small team, particularly as we observed in the Cretan case, engineers frequently end up practicing water law in regions where lawyers with expertise in water or environmental law are rare.[2] Lawyers and engineers both communicate in highly technical languages, which are frequently difficult to translate. For example, when thinking about "water" a lawyer might first consider "property" (indeed, water law in the U.S. is frequently first taught in a property law course), but "property" to a lawyer is likely to be a specialized area of law composed of theory, regulation, treaties, constitutions, judicial decisions, etc. (all of these shifting, appearing, or disappearing depending on the jurisdiction). Not being an engineer I do not know what an equivalent example might be, but I imagine that the differences in training would result in quite different results. Sometimes the words might be the same, but the meaning of the words is not.

My year-long experience as a law student engaging in water law was personally transformative. It broadened my view of law, emphasizing both the extreme differences in law between jurisdictions and the necessity of engaging with other disciplines in areas like water law. It also highlighted the problems of such an approach. In the end, it made me aware of the world beyond the American law school.



The Lasithi Plateau. Photo: Diana Biller, 2012.

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ENDNOTES

1. See Kampa & Bressers (2008), for an excellent and detailed overview of Greek water law over the past century. Because of my inability to use sources written in Greek, I rely heavily on this article in this section.
2. In the province of Lasithi, for example, there was reportedly only one lawyer whose work focused on environmental issues.

19. The Restoration of Ancient Water Cisterns

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FIGURE 1

From as far back as the Bronze Age, Cretan communities have relied on man-made rainwater cisterns and spring-fed wells to supply water for irrigation and domestic needs.

Damaged cistern near Neapolis, Crete. Photo: Sheila Saia, 2010.

Abstract

Water scarcity is a complex and emerging issue in the Mediterranean region. Local governments like the Municipality of Lasithi in Crete, Greece, must strive to achieve European Union directives for water quality and quantity while adapting to reductions in rainfall and meeting growing demands for water from agriculture, tourism, and domestic uses. One potential solution to this growing demand could include coupling modern water resource management strategies and publicly defined goals with the restoration of urban water cisterns. A combination of new and old water conservation strategies may benefit the local community as well as the groundwater supply.

KEYWORDS: WATER SCARCITY, CISTERNS, GROUNDWATER, WATER RESOURCES MANAGEMENT

In the village of Karydi on the Greek island of Crete, an elderly farmer stops to chat with me and my friend Giannis as we inspect the old stone cisterns that capture rainwater (Fig. 1 and 2). The farmer tells us how important these man-made, stone-lined pits once were to the socioeconomic health of her local community. She is worried about the municipal water supply, which was first installed about fifty years ago. The system has led many of her fellow villagers to lose touch with their land and limited water resources. "Everyone used to rely on the cisterns for their crops, but these days young people aren't interested in farming," she says. "They move to the cities in search of jobs and leave people like me to care for the fields and cisterns."

Despite recent pressure from the European Union (E.U.) to implement natural resource conservation policies, water over-abstraction continues to be an issue throughout Greece. According to figures published by the Organization for Economic Cooperation and Development in 2005, freshwater abstractions in Greece increased 73 percent between 1980 and 2002. While Greece is among the region's "water-rich" countries with an average per capita water availability of 6,765 cubic meters per year – compared to values of less than 1,500 cubic meters in most Eastern and Southern Mediterranean countries – water scarcity is becoming more common on a local scale, especially in the Aegean Islands. Yet, in general, few Greeks are aware of the pressure on their local water resources (see Ch. 17 and 20).

This disconnect between policy and reality can be ascribed to the interaction of many complex factors. Officials must consider projected yearly rainfall reductions of 5-20 percent, while balancing population growth with the expansion of tourism and agricultural development. As different industries grow, large-scale groundwater extraction from deep-drilled wells is replacing small-scale traditional water supplies, like cisterns and shallow wells. This makes it more difficult for community leaders and their constituents to understand and overcome the impacts of their decisions on the aquifer, a natural resource they cannot see but which is directly connected to the springs they use.

For example, increased irrigation demands for agriculture in the Messera Valley in southern

FIGURE 2

A cistern with steps near Neapolis, Crete. Source: Sheila Saia, 2010.

central Crete have lowered the groundwater table by nearly 45 meters in the past 10 years. In addition to reducing the water availability, over-pumping the aquifer draws seawater into wells near the coast. As a result, local governments spend more to meet current water quantity and quality demands.

From as far back as the Bronze Age, Cretan communities have relied on man-made rainwater cisterns and spring-fed wells to supply water for irrigation and domestic needs. As groundwater extraction technologies improved and Greek communities aspired to the same living standards as their western neighbors, groundwater wells became more and more common. Deep-drilled wells were first introduced in the 1960s and 1970s as shallow well pumps no longer met agricultural and domestic water demand.

Adjusting to growing demand

Most of the inhabitants of Karydi are still farmers, though a growing number are finding jobs in nearby urban areas such as the coastal city of Agios Nikolaos. The villagers rely on publicly supplied groundwater from deep-drilled wells to meet their domestic and agricultural water needs. Unlike many Greek islands, where local communities depend fully on imported water, Karydi's local aquifer capacity is expected to meet projected domestic water needs and current agricultural demand for the next ten to twenty years. However, this projection does not account for potential reductions in rainfall due to climate change or shifts in tourism and agriculture. Like elsewhere around the Mediterranean, tourism is a major income generator in Greece, but also a large consumer of water. Around 15 million tourists visit the country of 11 million every year – the majority during the dry summer months – placing added pressure on water resources. Agriculture is still by far the largest water consumer in Greece, using 80-85 percent of the country's water resources. Irrigation has increased exponentially over the past 50 years, covering 41 percent of cultivated land today (see Ch. 17).

Reintroducing the old

As an E.U. member, Greece has committed to meeting the guidelines proposed in the European Union Water Framework Directive by 2015. Specifically, the directive outlines fair water-pricing policies that promote sustainable water use (see Ch. 18). In other words, water utility prices should reflect the costs of water abstraction, distribution and treatment. While working under these guidelines, and realizing the necessity to address rising demand and the growing threat of climate change, community leaders are trying a new – or should we say old – approach to water conservation.

Nikos Kastrinakis, the deputy governor of the Municipality of Lasithi, collaborated with a team of students and professors from Cornell University to establish a water resources management plan that links traditional and modern water conservation methods and identifies associated areas of improvement (see Ch. 20). Several projects have been proposed, including plans to restore urban water cisterns and use them to water municipal parks. These self-sustaining, restored cisterns will help the local community reconnect to their water resources. Additional benefits of this restoration project include historical and cultural preservation, job training, community education, and backup water supplies.

Besides the restoration of cisterns, local leaders are considering three modern water resource conservation methods including interdisciplinary management, public participation and the establishment of quantitative and qualitative goals. By understanding the quantity and quality of their water resources as well as the community's perceptions and values, local leaders can better encourage citizens to become active caretakers of their local environment. The overall challenge of their efforts is to balance groundwater recharge with groundwater extraction (see Ch. 17). Only then will they have

Most farmers in Lasithi – the region of northeastern Crete of which Karydi forms a part – maintain traditional non-irrigated olive orchards, but in other regions water-intensive crops such as citrus are being in introduced. Citrus crops fetch higher prices, but require nearly twice as much water as non-irrigated olives. Karydi farmers who irrigate their crops first look to cisterns to supplement their municipal water demand (Fig. 3). It is more economical for them to water vegetables and livestock with water from a local cistern than to pay for municipally supplied water. However, many cisterns in the surrounding countryside have been abandoned because they are expensive to fix.

FIGURE 3

Cisterns in an olive grove, Crete. Photo: Sheila Saia, 2010.

Most farmers in the area of Karydi in north-eastern Crete maintain traditional non-irrigated olive orchards, but in other regions water-intensive crops such as citrus are being in introduced.

a viable solution that will meet the current and future needs of humans and surrounding ecosystems.

This article was previously published in Revolve *Magazine's special report* Water Around the Mediterranean *in February 2012.*

FIGURE 1

Parts of Crete already suffer from water scarcity. Photo: Tammo Steenhuis, 2012.

20. Water, Life, and Civilization in Crete and the Mediterranean

Nikos Kastrinakis
Governor of Lasithi Region, Crete, Greece

More than anything, what we need in Crete is rational and "civilized" use of water by all.

In 2008, as mayor of a municipality in the province of Lasithi, Crete, called Neapolis, which would soon be incorporated into the Municipality of Aghios Nikolaos, and having already established a strong relationship with the Center for Greek Folklore of the Academy of Athens under the directorship of Professor Kaiti Kamilaki, I co-organized a conference with Cornell University, the Agricultural University of Athens, the Region of Crete, and the Center for Research and the Advancement of Cretan Culture from 10 to 13 June 2008. The title of the conference was 'Water-Life-Civilization in Crete and the Mediterranean'.

The conference considered the status of water, i.e. quantity and quality, the health of water, the influence of water on the environment and on biodiversity, issues of management, and the formation of a culture of water, as well as ways of confronting the problems of water management by individuals, by institutions, and by society. The presenters at the conference considered water diachronically from ancient times to the present.

The triptych Water, Life, and Civilization is an important and inexhaustible subject, with multiple dimensions. Experts from various countries around the world participated in the discussion, approaching the topic with great seriousness, offering a variety of opinions. The conference ended with a visit to the only palm forest in Europe, near Vai Siteia.

The success of the conference demonstrated that our cooperation with all who participated should be ongoing. Everyone who participated realized that the island, particularly the Neapolis region, is dry, so there was genuine interest and anxiety about this social and cultural treasure, water (Fig. 1). In view of this, Cornell University researchers saw the venture as an important one and decided to continue their collaboration with us.

In addition to our general anxiety about the water situation in Crete, and without wishing to be an alarmist, I want to mention climate change, which will certainly affect Crete, and which predicts reduced but more intense rainfall, i.e. an increase in extreme drought and also flood conditions.

With the same cooperation and enthusiasm, we organized a second conference on 'Water-Life-Civilization in Crete and the Mediterranean in 2010'. At the end of the conference, we hosted three graduate students from Cornell, who spent the following three weeks collecting data from individuals and institutions, and amassed a considerable amount of information.

The data they collected was coordinated under the leadership of Professors Tammo Steenhuis (Biological and Environmental Engineering, Cornell) and Gail Holst-Warhaft (Mediterranean Studies Initiative and BEE) and published in a volume entitled *Water on the Brink: A Water Profile of Neapolis, Crete*. Translated into Greek with the assistance of Global Water Partnership-Mediterranean in Athens, the report was presented, a year later, to the Municipality of Neapolis.

In 2009 there was a conference at Cornell, in which scientists from various countries participated. As Mayor of Neapolis I took part in the conference and gave a presentation about our region, especially related to the culture of the region and the management of water from ancient times to the present. I also showed a video of the historical evidence of water management, including water troughs, fountains and irrigation channels, many of which had been abandoned (Fig. 2).

In the summer of 2012, Tammo Steenhuis and Gail Holst-Warhaft brought two young scholars to Crete: Diana Biller, a Law student and Cathelijne Stoof, a post-doctoral fellow in Environmental Engineering (see Ch. 17 and 18). Again they spent several weeks on Crete, gathering data on the management of water at the level of the island as a whole, encompassing the four provinces of Lasithi, Heraklion, Rehtymnon, and Chania. Parallel with their research, we, as a municipality, began some activities with the aim of sensitizing our citizens to the conservation of water, to the rational use of water, and to the repair and reuse of the rainwater cisterns that exist in our region. We aimed to create a cultural network that would draw visitors to an area with many cultural characteristics related to the management and distribution of water, to development, to life itself, with the simplicity and philosophy of our ancestors.
Among other things, we undertook a feasibility study for the restoration and reuse of rainwater tanks according to the prototypes of our ancestors. Rainwater cisterns are small tanks that have been continuously in use since ancient times, to collect and store winter rainwater (see Ch. 20), and use it with respect for the sacred

FIGURE 2

Ancient fountain in Neapolis, Crete. Photo: Sheila Saia, 2010.

nature of water, and to fully exploit it for various household uses throughout the summer.

We organized a public site, 'Observation of the Civilization/Culture of Water', which the townspeople could visit or access online to find information not only about hydrological but also cultural facts. Unfortunately, this site was not maintained by the new municipal administration.

I stress again that our ancestors, our wise forebears, showed us how to eat, how to use water and agricultural produce, how to exploit the environment and nature according to their rules, maintaining a balance, unlike today when we try to impose our own rules, disturbing the balance of nature and then try to correct our mistakes caused by these interventions, not by nature. Then we ask ourselves how these extreme phenomena occur! Here we must remember the mathematician and pre-Socratic philosopher Thales, one of the "seven wise men", who in the fifth century BC said: "Water is the beginning of all things."

More than anything, what we need in Crete is rational and "civilized" use of water by all, but especially by the institutions that are concerned with water in the region: municipalities, Local Organizations for Land Reclamation Works (TOEB), and other local authorities that work with water.

This article is an abridged version of Governor Kastrinakis' presentation at the 'Water Scarcity, Risk and Democracy in the Mediterranean and Beyond' conference, which was held at the Cultural Center of Athens, 12-13 April 2013.

The Mediterranean is one of the most arid regions in the world. Hosting more than 50 percent of the world's 'water poor' population, it holds only 3 percent of the world's freshwater resources. The region's growing water crisis differs from north to south, from west to east and from country to country. Some issues, like climate change, affect the region as a whole; others are specific to a particular country or a group of countries.

But water is a problem for the region as a whole, and solutions found in one country may, in time, be applied in another. More importantly, addressing the problem of water shortage and pollution in the region requires a combination of technical, social, economic, political, and cultural knowledge. Only such a mosaic of skills and approaches can hope to alleviate one of the most urgent crises this region has ever faced.

Drawing on the rich diversity of the region's water history and traditions, *Water Scarcity, Security and Democracy: A Mediterranean Mosaic* brings together contributions from a variety of countries and disciplines. The book takes a broad interdisciplinary approach, presenting a range of scientific, technical, historical and cultural perspectives on water management in this water-scarce region, and showing how the Mediterranean can serve as a living laboratory in the search for viable long-term water management strategies.

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