

We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

4,400

Open access books available

117,000

International authors and editors

130M

Downloads

Our authors are among the

154

Countries delivered to

TOP 1%

most cited scientists

12.2%

Contributors from top 500 universities



WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index
in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?
Contact book.department@intechopen.com

Numbers displayed above are based on latest data collected.
For more information visit www.intechopen.com



From Traditional to Modern Water Management Systems; Reflection on the Evolution of a 'Water Ethic' in Semi-Arid Morocco

Sandrine Simon
Open University
United Kingdom

"Society is like a pot: it can't carry water when it is broken" (African proverb)

1. Introduction

Which strategic water policy options are semi arid, developing, Muslim, countries going to take in order to face the dilemmas that typically characterize the dual - and potentially conflicting - aspiration to modernize the economy *whilst* respecting traditional socio-political practices and ways of life? This chapter focuses on the case of Morocco, described as one of the most liberal countries of the Muslim Arab world - and yet as a country that is keen to balance traditions and modernity -, in view of articulating a reflection on the conflicting interests that can clash when critical environmental and economic choices have to be made to position a developing country into the 21st century's globalised world.

The chapter focuses on water because of the crucial importance of that resource in a semi-arid country and because the ways in which it has been managed throughout centuries illustrate the changes in socio-political structures in the society. The focus on water in a semi arid country is symbolic of how precious natural resources are in the development of economies and societies. Morocco provides a fascinating terrain to explore ingenious traditional water management structures and processes both in urban and in rural environments. Thus, for instance, traditional water management systems represent one of the architectural and urban pillars of the medina of the UNESCO World heritage - and cultural and spiritual capital of Morocco - Fes, whilst *khetarras* in the rural South (for instance), provide a remarkable example of a well-thought, long-lasting system of water collection and distribution. This country also developed, in the last decades, massive modern water policies focused on the construction of dams and water transfers. Economic principles constituted one of the main drives in the *politique des barrages* of the previous king (Hassan II), with a strong focus on agricultural production and exports targets. Morocco has however somehow questioned its development path in this beginning of the 21st century, with the arrival of its new king and a sense that the development of the country could be re-thought and targeted differently. A new Charter of the environment was created, massive investments were geared towards renewable energies and, more importantly, governance systems were questioned. Centralized versus more local - and

potentially more traditional – approaches of resource management were discussed. In this context, could the expression “ ‘modern water management’ versus ‘traditional water management systems’ ” become “revisiting traditional water management systems in order to re-think and question the notion of modernity in the context of water management”? If so, it would mean that a new type of water ethics is progressively emerging in a context where both the notions of economic development and centralized environmental governance are being questioned.

The objective of this chapter is to demonstrate that this could be the case in a country like Morocco and to explore what this would imply for the years to come. The chapter starts by presenting traditional and modern water management techniques. The evolution of the political dimensions of water management is then explored, allowing the reader to appreciate the extent to which technical choices are of a political nature. The chapter then concludes on the emergence of a new water ethics, with a particular focus on new understandings of development and environmental governance.

2. Traditional versus modern techniques in water management in Morocco

Morocco is a semi-arid country where both traditionally and through modern techniques, management systems have had to be found to store, distribute, allocate fairly, treat ... clean and dirty water resources. Whilst Islam has equipped this North African country with ingenious traditional water management systems, growing populations and hence domestic needs, growing demands coming from economic development, as well as climate change extreme weather events (both droughts and floods) have altered the way in which people, technology and governance systems have been allocated to that scarce natural resource, *l'maâ*. This section concentrates on traditional and then modern management approaches, after having first presented the country's physical environment, its constraints and its potentials.

2.1 Water issues in a semi arid country

Morocco is located in the North West tip of Africa, with a small Mediterranean coast and a very long Atlantic coast, important mountain ranges – the Anti, High and Middle Atlas as well as the Rif mountains –, agricultural plains West of the mountains ‘crescent’, and deserts, East of it. It is therefore subject to the influence of highly diverse climatic conditions. Rainfall is distributed unevenly: it can vary from more than 1,800 millimetres per year (mm/year) in the northern part of the country to less than 200 mm/yr in the southern parts. More than 50% of the rainfall is located in 15% of the country's surface. The average precipitation - 340 mm per year - therefore has to be apprehended in a context of great climatic diversity. On the whole, it is fair to say that the country is essentially semi-arid, if not arid, with 79% of the country located in an arid and Saharian zone, 14% in a semi-arid zone and 7% only in sub-humid and humid locations. Besides, it has been considered, since 2001, as being in condition of ‘water stress’ – that is, benefiting from less than 1000 cubic meters of water per inhabitant per year.

Various phenomena are aggravating the situation. First of all, due to **high population growth** (2% growth rate), water availability per inhabitant would have dropped from 1200 cubic metres per inhabitant per year (m³/inh/y) in 1990, to 950 m³/inh/y in 2000. In 2030,

that figure should drop to 500 m³ (Et Tobi, 2003, p.6). The increase in water demand is therefore daunting. Second, **climate change** has resulted in a series of droughts (1982-1983, 1994-1995, 1999-2000) and localised floods (1995, 1996, 2001, 2002, 2010, 2011) and will make the average surface and underground water flow decrease by 15% between 2000 and 2020, following studies carried out in 2001 (Agoumi, 2005, p.36,37). As this author stresses, climate models predict a warming up of the North African region of 2 to 4 degrees Celsius throughout the 21st century, accompanied by a reduction in rainfall of 4% between 2000 and 2020. In Morocco, research centers estimate that the increase in temperature between 2000 and 2020 will probably be in the range of 0.6 to 1.1 degrees C., considerably affecting the

Internal Renewable Water Resources (IRWR), 1977-2001, in cubic km	Morocco	Middle East & North Africa	
Surface water produced internally	22	374	
Groundwater Recharge	10	149	
Overlap (shared by groundwater and surface water)	3	60	
Total Internal Renewable Water Resources (surface water + groundwater - overlap)	29	518	
Per capita IRWR, 2001 (cubic meters)	936	1223	
Natural Renewable Water Resources			
	Total, 1977-2001 (cubic km)	29	X
	Per capita, 2002 (cubic meters per person)	936	X
Annual River Flows:			
	From other countries (cubic km)	0	X
	To other countries (cubic km)	0	X
Water Withdrawals			
	Year of Withdrawal Data	1998	
	Total withdrawals (cubic km)	11	X
	Withdrawals per capita (cubic m)	399	X
	Withdrawals as a percentage of Actual Renewable Water Resources	42.6 %	X
	Withdrawals by Sector (as a percent of total)		
	Agriculture	88 %	X
	Industry	2 %	X
	Domestic	10 %	X

Source: Water Resources. COUNTRY PROFILE – Morocco. World Resource Institute 2006.
<http://earthtrends.wri.org/text/water-resources/country-profile-126.html>

Fig. 1. Provides general data on water in Morocco, the Middle East and North Africa

water cycle. The effects of climate change on groundwater recharge in Morocco are particularly well documented in Van Dijck et al (2006). Third, some **existing modes of water management** could be considered as worsening the situation. Slimani (2010, p. 60) stresses that Morocco is particularly behind with regards to water treatment management: whilst Morocco produces more than 750 million cubic water annually, only 100 million cubic meters are treated and 10 million are re-used. According to the Ministry of Trade and Industry, the cost of environmental damage is calculated to be around 8% of Morocco's annual GDP - 2.5 billion dollars (ref. <http://www.fm6e.org/fr/notre-fondation.html>). This includes serious problems of water pollution: organic pollution and pollution by heavy metals, salination of water and siltation, increased in case of climate change. Currently, 88% of water is used for agricultural irrigation in Morocco (compared to an already very high 80% water allocation to agriculture observed in the MENA region), and many consider that water is being managed in their country in an irrational manner, with over-exploitation of groundwater resources and use of clean, expensive tap water in inappropriate ways (ACME, May 2011). In order to deal with the current Moroccan water crisis, authors such as Agoumi (2005) have identified main areas in which efforts should be focused such as integrated energy-water policy, de-pollution and water savings, optimization of water demand, better monitoring of water supply and demands. Others have suggested to also jointly manage water and forest resources in an integrated way (Et Tobi, 2003). Responses to crises have adapted to needs and constraints and we will soon see that, whilst traditional techniques were valuing small scale coherent management systems that protect the social and political fabric of communities, more modern techniques have opted for intensive economic development based on the prioritization of agricultural exports and less concerned with the social and political impacts of technological choices opted for. I will come back to this very important point throughout the chapter, but I suggest to take it for now as a point of reflection - a point that is captured in the following quote by Allan (in Turton and Henwood, 2002, p.30): "The most important solution for water deficit economies is socio-economic development. With socio-economic development comes the adaptive capacity to deal with the challenge of water scarcity. Water scarcity has two orders. First-order water scarcity is the scarcity of water. Second-order scarcity is that of the capacity to adjust to the scarcity".

2.2 Traditional water management approaches

Islamic civilization has acquired a great reputation in terms of its ability to develop ingenious approaches to water management and to agricultural practices that are well adapted to particularly harsh climatic conditions. Some authors have explored in detail the reciprocal influences that North Africa and Andalusia (in the South of Spain) had on each other, in particular during the period from 700 to 1100 where a genuine Islamic agricultural revolution took place. Authors specialised in North Africa, such as Pérennès, highlight the fact that numerous and diverse water management systems can be found in that area of the world which developed, in its past, subtle water distribution systems that he describes as a 'social management system of scarce resources'. The prestigious water management heritage of North African countries goes back to pre-Islamic times when numerous irrigation techniques emerged from the creation of sedentary urban and rural civilisations of the desert, mostly Berbers. The Arab and hence Islamic expansion towards the West spread various water management and agricultural techniques. The introduction of new plants

coming from India and the Sassanide Empire (spread from the Khorassan to Mesopotamia, 226-651), such as rice, lemon trees, cotton, spinach – to quote only a few -, acclimatised and then largely spread by Arab dynasties during the VIIIth and XIIth centuries, lead to the introduction of new irrigation techniques themselves leading to the intensification of agricultural processes. It is in the VIIIth century that the Arabs introduce the *noria* (the water wheel activated by an animal, a donkey or a mule, generally), for instance, as well as the *qanats* (small scale dams).

A few characteristics of traditional water systems in the Muslim, North African, world must be highlighted and are particularly important in the light of this chapter's argument. First, these techniques were extremely well adapted to the natural environment and consequently varied in their types. They dealt with urban as well as rural environments, and used groundwater as well as surface water. Second, water management was paying attention not only to the diversity of the physical environment but also to the variety of users and water management conflicts were integrated in the management system of the rare resource. Finally, it is worth noting that ingenious traditional water management systems in North Africa, and Morocco in particular, were never born out of great, big-scale projects such as those observed in the times of Pharaonic Egypt. As Pérennès explains, "the rise of irrigation techniques in the Muslim world did not emerge from a strong, despotic and centralised State" (1993: page 77). Quoted in Pérennès, Paul Pascon also explained that "traditional water management systems had numerous functions other than solely that of managing water resources. In semi-arid areas where water can be disputed, they captured the complex way in which societies functioned" (in Pérennès, p. 19). In the context of this chapter, the point is the following: the move from traditional to modern water management techniques is controversial in that it is seen as one of the causes of current difficulties the country is encountering in the management of water rare resources – at least by certain authors. It is not only a physical, technical problem but, above all, a political societal problem in that "technical choices are first of all social choices: the choice of the 'great water management systems' based on the construction of large dams, for instance, is justified by its centralising objective and its capacity to create, for rural communities, dependency situations generated by the need to manage these large infrastructures and equipment" (Pérennès, p.19). The dismantlement of certain aspects of the traditional Moroccan society through the introduction of modern, foreign, natural resource management systems is one important example of how development can be counter-productive. If "Water tells the story of societies" - (Pérennès, 1993, p.21) then, what comes next is part of the stories to be told about old, modern and future Morocco.

2.2.1 Water canals and water clocks in rural Morocco

How do traditional water management systems adapt to arid environments? What are examples of the techniques that characterize the great Islamic hydraulic heritage? Here, we have chosen to describe a few techniques because they contributed particularly well to two aspects of traditional management. The first one relates to the adaptation to arid environments. The second one captures unusual water conflict management characteristics.

One first example of traditional water management system that is worth presenting is the system of *khetarras*, or "subterranean aqueducts engineered to collect groundwater and channel it to surface canals which direct it to fields and community wells" (Lightfoot, 1996,

p.261). Authors agree to say that the most spectacular networks of *khetarras* that still exist can be seen in Morocco: a network of 600 *khetarras* could still be seen in the 1980s in the Haouz plain of Marrakesh, whilst around 400 others exist in the area of the Tafilalet and the Souss. *Khetarras* provided the only reliable irrigation water for North Tafilalt until the early 1970s, when new water management systems were introduced by the government. In the Haouz, the network – when in full use – was 900km long and contributed to the brilliant growth of the city of Marrakesh. The network was originally introduced through the Iranian technique of the *qanat* by the engineer Abdallah ben Yunus at the end of the 11th century, improved in order to adapt to the physical specificities of the plain and transformed into a very specific technique of the *khetarras*, built and managed by the *khatatiriya*. The *khetarras* that are still active nowadays are maintained by all community inhabitants and sometimes friends from neighbouring villages against some money or favors. In the 1990s, in order to encourage the exploitation of every possible water source, the local government of certain areas (e.g. Errachidia in the South East of Morocco) was providing small grants for the maintenance of *khetarras*. Within a *khetarra*, the water flow is equivalent to 10 litres per second, on average – water never stops flowing. *Khetarra* irrigation is a sustainable water recovery method. Because it relies entirely on passive tapping of the water table it does not upset the natural water balance, whereas the withdrawal of water by pumping can lead to aquifer depletion (Lightfoot, 1996, p.262).

Traditionally, another system of, this time, surface water distribution, is well known in Morocco and still in use: it is the system of *seguias*, main system of collect, distribution and transfer of water. In the Haouz plain, 150000 hectares of land are irrigated by a system of 140 km of *seguias* and 1000km of smaller canals derived from the *seguias* (the *mesrefs*). The *seguias* are organized in the shape of fish bones, with the *seguia* itself, deviating water from the river, to the *mesrefs*, distributing water much further from the oued (river) to the fields to be irrigated. The loss of water through infiltration can be very high (up to 50%), but it ensures that there is still water to be captured downstream – since little dams upstream capture the majority of available water. In order to avoid conflicts over irrigation, an alternative system of *seguias* irrigation to the left and to the right of the river is put in place. This distribution



(a)

(b)

Fig. 2. a) Cement *seguia*; b) Natural *seguia* in Tata, Southern Morocco

and allocation of water requires a set of agreements between tribes living along a river. These agreements led to the creation of two types of *seguias*, observed, in particular, in the valley of the Draa in the south of Morocco. The '*melk seguias*' (56 out of 89) allow people to privately own part of the water. Depending on the water pressure in the *seguia*, and the number of farmers allowed to benefit from it, people take it in turn to benefit from a certain 'time of irrigation': the *noubas* (water days) are subdivided in these specific amounts of time. Other *seguias* have a collective status - they are the '*allam seguias*' (27 out of 89 in the Draa valley). Any transaction concerning the land then also includes the water with which it is intimately linked. The order in which land is being irrigated is entirely of topographical nature. The *allam* system exists in communities that are particularly coherent and united. Despite this, in both systems, an *amazzal* ensures that there is fair distribution of water and manages conflicts in case these rise, as the next section describes in more detail. The objective of this section was to show that the *seguia* system is well adapted to both the physical geography and also respects a human network.

A second dimension of traditional water management systems in Morocco is the way in which these manage *conflicts over water*. This dimension has been the subject of a thorough study by Wolf (2000) and has been explored by various other authors (Pérennès, etc.). What caught their attention was the fact that Berbers' methods of conflict resolution on water were based on:

- the *allocation of time, not quantity* - villages, family, individuals benefit from set days for irrigation of their crops. In some instances of water markets (e.g. in the Draa valley, in the South of Morocco), the commodity bought is time for water usage, not water quantity, which circumvents the need for storage and Islamic codes. Wolf reported in one of his interviews that 'Berbers felt the idea of buying and selling water was both repugnant and contrary to the tenets of Islam) (see Figure 3 water clock below);
- the *prioritizing of use* - this is a method used to deal with a fluctuating supply, emphasizing the fact that it is necessary to prioritize the use to which water is put. In Islam, the priority is drinking for humans, followed by drinking for animals. Next is irrigation (which flows through canal systems, such as *seguias* or *khetarras*, presented earlier). Next is water for mills, and the last priority is irrigation water brought to the land through modern means (pumps, etc.)
- the *protection of downstream rights* - upstream users could be tempted to over-use water, but this is prevented both by the allocation of water by time and also by regional laws that forbid the use of modern materials (cement, in particular) for canal intakes. The traditional methods of piled rocks, although potentially qualifies of 'inherently inefficient', guarantees that a substantial quantity of water can still reach downstream users.
- *process techniques* of conflict resolutions - these tend towards the formulation of mutually acceptable solutions through facilitators (marabouts, or '*a'alam*' - also designed as the '*amazzal*' in other publications (Pérennès) - who represent the users in dispute and are in charge of negotiating a solution. These facilitators are also in charge of choosing the irrigation timing schedule, as well as a ceremony of forgiveness (the '*sulkha*'), once the dispute has been resolved. The *a'alam* rotates from a family lineage to another.

Water conflict management techniques were also developed in towns, such as Fes, where water circulated through a 70km long network of canals and was regulated by a corporation of specialists called the *qanawiyyum*.



Fig. 3. a) Water clock in Southern Morocco – it takes 45 minutes to fill the pot, time used as an irrigation unit; b) List of benefiting water users

The ability of the Berber communities to traditionally deal with water conflicts in this way is based on their very strong **social capital**, a term extensively explored originally by Robert Putnam and revisited in the context of Morocco by sociologist Fatima Mernissi who defines it as a wealth that improves efficiency when people respect each other and prioritise common public interest before individual wants. She explains that a people who, like the Berbers, have *tiqa* (trust), *ta'awun* (the capacity to co-operate), *tadamum* (solidarity), and *hanan* (unconditional kindness), have a very strong social capital. Thus, she defends the principles of tribal democracy (in which collective and specific rights are being defended) against 'occidental democratic principles' that protect individual and universal rights. "Only nations who protect traditions of co-operation and of solidarity, encouraging people to invest in common projects", she concludes, "will triumph in centuries to come" (1997, p.19)

2.2.2 Urban traditional management: The example of Fes

The Islamic prestigious water management heritage also refers to urban water management and the integration of water within Islamic architectural concepts. Muslim communities such as Moroccan ones, have traditionally dealt with water issues and shortages also through their selection of sites for settlements, urban integrated design and through the constant reminder of the spiritual value of water in their mosks. As Michell explains, "In both the hot and dry and the hot and humid areas of the Islamic world, architecture has been a means of controlling the environment by the creation of domestic micro-climates, of which the courtyard house is the most common example. In Islamic popular architecture, the insulation properties of many natural materials have been exploited and a range of ventilation systems developed (...) Water is an essential component to, and an illustration of, the nature of Islamic architectural decoration. Its use for decoration, as well as for coolness, is best seen in house and palace architecture rather than in religious buildings, where the paramount function of water is for ritual purposes" (Michell, 1995, p.201, 173). It

is no surprise if the spiritual and cultural capital of Morocco, Fes, was created in an area that is rich in springs and where various sites have been, and are still used, for health purposes (the *stations thermales* of Moulay Yacoub and Sidi Harazem, for instance, extensively described by Doctor Edmond Secret in his 'Sept Printemps de Fes' for their health benefits).

Architecture is indeed more than a history of form and style. It illustrates cultural and environmental factors, as well as the way of life of the people from whom it is built. Elements of traditional architecture are actually being re-used through 'green architecture' nowadays - architecture that seeks to "construct a human habitat in harmony with nature" (Wines, 2000, p.8). It does so under the popular appellation of 'Sustainable architecture'. In ancient cities, such type of architecture usually meant relying on construction technology development based on regionally accessible materials which satisfy the demands of climate, topography, agriculture, as the main means for survival.



(a)

(b)

Fig. 4. Water in architecture in UNESCO urban World Heritage, Fes a) 14th century water clock; b) Nejarrine fountain

Fes provides an interesting urban example of how ancient Islamic civilizations have developed urban strategies to distribute and manage water resources strategically. Serrhini, Director of the ADER Fes, explains (Serrhini, 2006) how, following Moulay Idriss' selection of a water rich site to create it, the city expanded in the hands of a water conscious and ingenious Berber dynasty, the Almoravids. From then until the XIXth century, three types of complementary water infrastructures were developed and became exemplary.

The first one was the network of clean river waters, used for house cleaning, filling of basins, irrigation of gardens (with the help of *norias* - see Figure 5b), artisanal usages and to fuel mills.... - but not drinking. The water came mainly from the Oued Fes, divided into three smaller rivers directly North of the old town, where the water was distributed through a *r partiteur urbain* (Figure 5a), depending on the priority and volume of the water usage to be made (use for public baths, the *hammams*, or domestic usages, or uses for the tanneries).

The infrastructure was based on a system of underground tunnels and surface canals where water flew simply following gravity, down through the old town, the medina. There was also the network of spring water, the drinkable water, linking some twenty springs around the old town into a pottery canals network called the *maâda*, feeding seventy fountains for public water use, as well as private houses. Finally the water sanitation network was organized underground through the *Sloukia* which took the water outside the city towards the Oued Sebou. At the time when that structure was built, the network was sufficient for the population it served and the wastes led outside were sufficiently rapidly biodegraded. The various infrastructures and the architectural attention that was paid to them showed how much water was valued. Economically, a fair allocation of water resources was ensured thanks to a careful management of the volume being directed towards various types of activities. Spiritually, water was beautifully present in fountain and ablution rooms of mosks. Environmentally, water was used carefully and recycled as much as possible (e.g. the water from fountains was re-orientated for it to be re-used in gardens) before it was got rid of.



Fig. 5. a) Water distributor, Fes b) Noria from which the water flowed to the distributor

The urban structure, with public fountains accessible to all, was respectful of the right to all to access and consume water freely. Moreover, the tradition of the public bath, the *hammam*, allowed a more efficient use of natural resources – both water and fuel to heat it. The *hammam* has been described by Sibley as “a sustainable urban facility which not only promotes cleanliness and health of the urban dwellers but also social interaction: it serves as a meeting place for both male and female communities” (Sibley, 2006, p.1). She also explains that the religious requirements for washing in Islam played an important role in the way *hammams* developed. *Hammams* are generally well embedded in the urban fabric of the city, located along the underground water channels and built on sloping sites to facilitate drainage. The furnace of the *hammams* is often integrated to a bakery to make economic use of the firewood or by-products from other industries such as olive pits used to heat up the water. “The amount of water each client receives is limited to four to six traditional buckets – anything above which has to be paid for” (Sibley, 2006, p.3).

Things have changed. The size of the medina population to be provided with both water and sanitation, in particular, has considerably increased. Family size has reduced and the French presence during the Protectorate (1912-1956) led to the creation of the 'ville nouvelle' where many people ended up moving to. Private bathrooms were built in modern houses and the tradition of the *hammam* is slowly declining – although 30 plus *hammams* are still in use in the medina. Parallel problems are nevertheless growing, notably the source of fuel to be used - or not - for public baths in a densely populated part of town. Economic activities and modes of production (for instance substances now used to treat animals' skins in the tanneries) have changed in such a way that relying on a traditional system of water distribution and usage is not adapted anymore. This is an example where tradition and modernity cannot go hand in hand anymore, despite the wishes of King Mohamed VI. But the various initiatives aimed at restauring these old hydraulic structures and to learn from them demonstrate that they could still be useful one day and that they are still highly valued.

This is true not only nationally but also internationally: the Arab Fonds for Economic and Social Development is contributing to restauration works and the old medina of Fes is one of UNESCO's World Heritage Sites, mainly due to its integrated urban organization. Beside, and thanks to the systemic nature of each component of the urban fabric of a medina such as Fes, learning lessons related to restauring one component (for instance how to draw lessons in sustainability when improving the running of *hammams* in terms of construction, heating system, water uses, social dimensions, etc.) will lead, in a domino effect, to re-learning about the sustainable dimensions of traditional urban Islamic structures, as a whole.

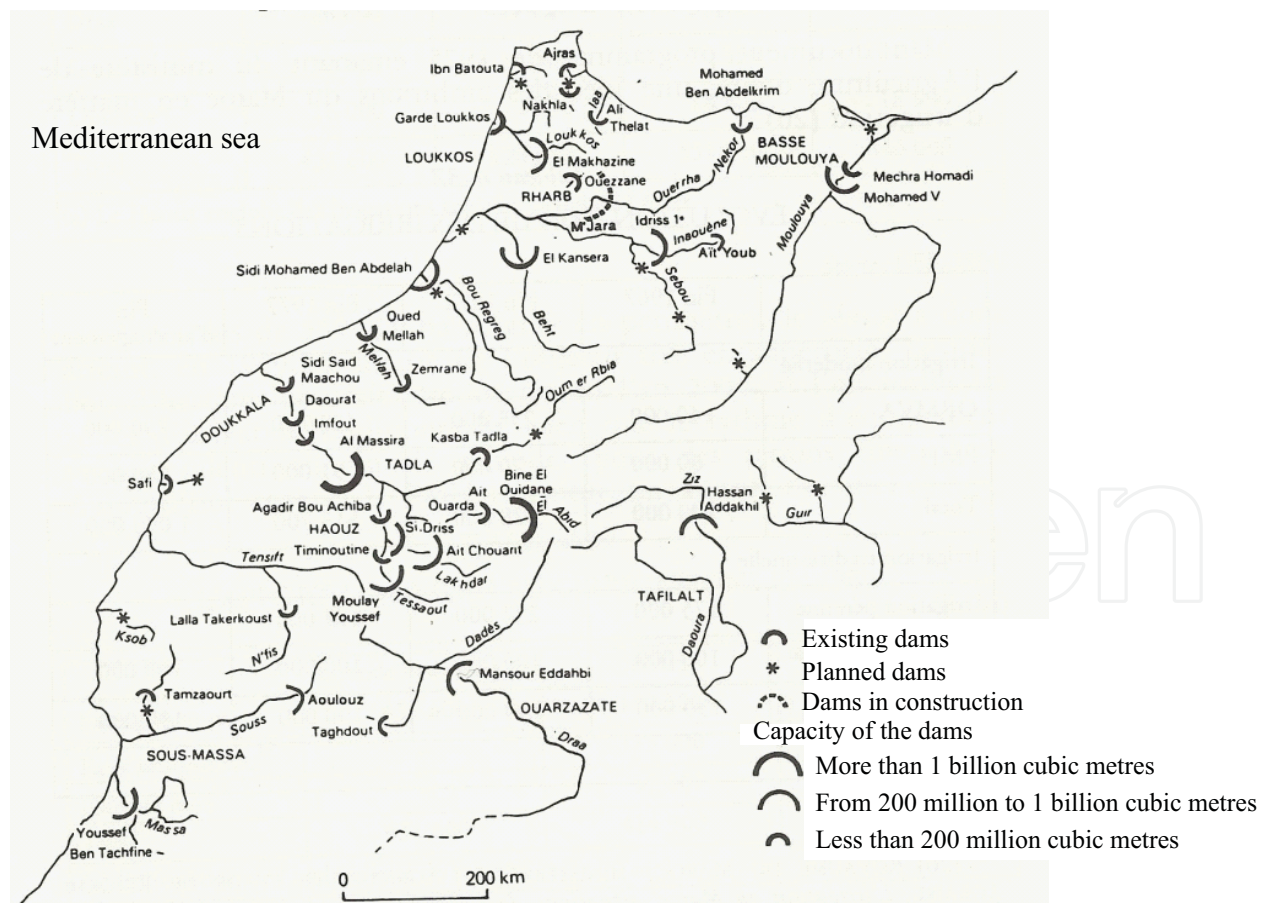
2.3 Modern technical approaches

The modernisation of water management in Morocco was very much geared towards 'fueling' agricultural production, itself targeted as the main component of the country's modernisation and development.

In line with development objectives, themselves emerged out of the post-independence era in the 1960s and focused on modernisation objectives for the country, Morocco chose to put together a strong *politique des barrages* (dam building) in place, aimed at strengthening its irrigation potential throughout its territory. The irrigation strategy was characterised by the need to separate the country into various irrigation zones. The Doukkala plain, in particular, received special attention because of the citrus production it generates for exports. The technical irrigation equipment that that area benefited from increased from 4700 hectares in 1960 to 14000 hectares in 1967. The whole question focused on how to modernise agriculture and move away from traditional models of production and irrigation. An important issue became the size of the production unit, which had not only technical but also political implications. French 'colonisers' under the Protectorate had large-size agricultural pieces of land, located in fertile areas of Morocco and focused on export crops. The economic Plan of 1960-1964, which encouraged intensification of agricultural practices, somehow stagnated – fought against by 75% of rural families who still only had less than 2 hectares to work on and were still subject to traditional systems that were against intensification practices. The re-organisation of land ownership in Morocco was very slow, after independence, and it is only after 1973 that private colonial pieces of land were re-distributed. But, as Pérennes explained (1993, p.165), out of 100 hectares of colonial land, 35 went in the hands of rich

Moroccan land owners, 35 started being managed by the State and only 30 were distributed amongst little agricultural production units within the framework of the agricultural reform. Irrigation equipments and infrastructures benefited the richer and inequalities remained.

In order to modernise irrigated lands and agricultural practices, the State then decided to focus on new crops (with new crop contracts guaranteeing fixed prices to farmers as well as compensation in case of loss of crops). That system of 'integrated crops' included cotton, beetroot and industrial tomatoes. The State also funded part of the irrigation equipment under an agreement in which farmers had to progressively reimburse parts of the advanced sums and to pay a fee for water usage. In terms of technical choices, traditional irrigation systems based on gravity and *segouia* networks were extended into a fuller network (the *trame d'irrigation*). But the superimposition of a complex physical irrigation network based on traditional systems and a centralised mode of management did not lead to satisfactory results and many objectives of the *Réforme Agraire* could not be reached. Nevertheless, King Hassan II, in his famous Erfoud speech in 1974, and whilst international prices were in turmoil, announced a new technical option: *la politique des barrages*, in which he announced his target of irrigating 1 million hectares by the year 2000 - which was reached. Overall, budgetary choices went in that direction: in the early 1970s, 41% of the budget was aimed at the irrigation and agricultural sector - the building of dams, the purchasing of modern equipment, would overcome climatic constraints and water shortages.



Source: Pérennès (1993, p.173)

Fig. 6. Carte des barrages au Maroc Pérennès

A series of events (the mid 70s collapse in the prices of phosphate - resource which, at the beginning of that decade, had ensured high economic growth in the country through its exports -; in the mid 70s again, the increase in military expenditures; and then severe droughts in the 1980s) broke that momentum and led to sectoral adjustments that included a questioning of the 'grande irrigation' option. The PAGI (Programme of improvement of large scale irrigation) of 1985 changed the management system of these agricultural zones (which often became privatised).

The big question of 'what should be the place of the State and that of the farmers in agricultural development?' was once again asked and once again as technically as politically relevant. The 1980s led to programmes of structural adjustments and dependencies on the IMF services that had heavy consequences in the irrigation sector and economic orientations. Morocco respected IMF conditions, orientations and advises - more and better intensification of agriculture, less water wastes, choice of revenue yielding crops, etc. But the management structure - re-organisation of agricultural land; financial reform with subventions on the one hand and taxes on irrigated land on the other; re-allocation of management roles - was difficult to integrate and included new components such as the payment of water by farmers. Between 1980 and 1984, irrigation water pricing was such that certain irrigation practices were discouraged (aspersion). The method of 'economic sanctions' was therefore introduced but not politically backed up by regional authorities who considered water as a socially sensitive issue. The State - and the World Bank - then decided to help farmers with various credit systems that would allow them to become more entrepreneurial. But whilst average and big size exploitations benefited from that system, smaller ones remained marginalised because of the land ownership structure: the lack of ownership titles on collective lands and micro-funding systems made their access to credit difficult. Globally, big irrigation policies, in particular in the Doukkala, were successful. However, interestingly, farmers who had the choice, preferred to carry on cultivating on plots whose size was smaller than the encouraged 'official production sizes', and chose to carry on cultivating vegetables and cereals - crops perceived as giving them more independence and food security.

Technically speaking, at the beginning of the 21st century, as Abdelkader Benomar - director of research and planning at the Moroccan Secretary of State in charge of water and environmental issues - reported to Lamia Mahfoud (2011), Morocco is prepared to invest in massive initiatives in order to implement a strategy that will help in anticipating water shortages. The current trends, with regards to the management of water supplies, focus on the construction of more dams (60 large dams, also used for hydropower - a source of energy that saves on average 70,000 tons of oil per year (Doukkali, 2005, p.73), and 1000 little dams before 2030), the transfer of water (800 Million cubic metres planned to be transferred) from the North of the country to the South, the re-use of treated water, the de-salination of sea water. And when it comes to managing water demand, the Moroccan strategy focuses on improving water use efficiency in industries and in touristic units, to re-adjust water tariffs, to integrate water saving practices in the building industry, and to improve water usage practices in irrigated agriculture.

Many initiatives are undertaken in public-private partnerships. Beside, a new system of subventions established in 2010 aims at intensifying agricultural practices through massive subsidies by the state on agriculture machinery.

Technical efforts geared towards irrigated agriculture therefore remain high on the agenda. As Bennis and Tazi-Sadeq explain (1998), in Morocco there are still two types of irrigation: Large-scale hydraulics (GH), involving vast areas fed by high-capacity dams and providing year-round water supply (presently about 500,000 out of a potential 830,000 hectares); and small-scale hydraulics (PMH), involving small areas of several hundred hectares fed by water sources that are not highly regulated (e.g., pumps, water diversion, co-lineal reservoirs, spring water catchments, and flood waters). "The goal of the state is to reduce the amount irrigated by seasonal waters to 170,000 hectares, and increase the amount irrigated by year-round water to 510,000 hectares (60 percent). This measure should contribute in a major way to nutritional security, job creation, and the effort to slow rural exodus throughout the country. The goal will be reached through rehabilitation and modernization of equipment in the areas concerned, using traditional irrigation systems based on customary rules of water distribution" (1998, p.8). The way in which Morocco is trying to achieve these targets is therefore to create agricultural water users associations that will embrace these technical changes. This new approach, described by Bennis and Tazi-Sadeq as a 'very modern and complex concept of hydro-agricultural equipment', despite attempting to bring socially more friendly solutions to water supply and demand crises, has been questioned by these authors: "Will the population accept high annual costs for participation in investments that were decided without their consent, water fees based on consumption rates, and unit prices that exceed those that are customary to the region?"

One of the crucial questions of the *Plan Vert* in Morocco therefore remains centered on finding appropriate ways in which to engage people's participation in the making of its country's sustainable development. This is a political as well as an economic and above all ethical question, which will be discussed in the last section of this chapter.

2.4 The impacts of modern approaches on traditional water management systems

In terms of water and agricultural management techniques, historians have talked of a collapse of the Islamic civilization on cultural and technical fronts. Swearingen (in Pérennès, 1993, p. 17) explained that phenomenon by demonstrating that in Morocco, in particular, colonization had broken the coherence of rural societies in order to impose to them new and contradictory interests; those of the 'colons', those of the State, and those of metropolitan lobbies (such as those encouraging the construction of major infrastructures such as great dams in the colonized country). Important questions are currently being asked by certain people (and should be asked by a wider circle of, in particular, policy makers) concerning the appropriateness of certain modern water policies in the light of both ecological and climate but also social, cultural, and political changes. The example of the abandonment of the use of *khetarras* is merely one example amongst other significant changes, but it usefully illustrates the combination of factors involved in such changes.

In 1996, Lightfoot extensively studied that issue and explained how the *khetarra* system of the Moroccan Tafilalt were in the process of being abandoned as surface and groundwater supplies and of being replaced with diesel and electric pumping devices, as well as large dams. His studies highlight the regional impact of the entire *khetarra* system and emphasizes both the problem of water recharge as well as the social implications derived from the imposition of new techniques. A 300 km network of such canals was excavated in the Tafilalt region. When great dams were constructed upstream from the Tafilalt on the Oued

(river) Ziz, and concrete-lined government canals as well as unregulated use of diesel pumped wells were introduced, dessication started occurring. The availability and distribution of water changed dramatically. As Lightfoot explains "No longer is the oasis fed by the occasional flood or heavy spring runoff from the Ziz, and because the Ziz now infrequently flows at the Tafilalt, and only in concrete lined canals, groundwater recharge has been greatly inhibited while growing quantities of groundwater are being pumped out to make up for the dam-induced deficit of surface water. (...) The government canals provide a measured, cheap, reliable amount of water, but government resource officials and Tafilalt farmers concede that Ziz water is now insufficient - providing half their needs - and good only for supplementing the water coming from other sources" (Lightfoot, 1996, p.266). If, from the point of view of water availability, the introduction of new techniques in the Tafilalt is questionable, it also is from a legal perspective. The introduction of a new distribution system (the release of water from the reservoir) has meant that the 'water timers' no longer regulate water allocation. Moreover, in 1996, there was no authority to actually regulate the various diesel water pumps installed in the region (750 private ones). Modern techniques have therefore, at least in this case, proved to be potentially capable of providing greater quantities of water but not in a way that allows for groundwater recharge in the long run - not in a *sustainable* way. Culturally, the abandonment of the traditional irrigation techniques have altered the land use patterns of the oasis - less and less palm trees produced dates, traditionally traded from the oasis, as a result of sustained dessication and poorer groundwater reserves. Moreover, there have been important social impacts, such as the loss of local control over water resources." *Khetarras* were qsour-operated and collectively maintained, and intricate relationships had evolved to manage them and distribute their benefits according to each shareholder's inputs of land, labor, tools, and money. Diesel-pumped wells are often privately owned and, as a result, the traditional ties that bind village society are breaking down (p.268). With the overexploitation of water and the large scale depression of the groundwater levels in the area due to the construction of dams, new *khetarras* parallel to the old galleries would have to be excavated in parallel to the old galleries which would prove to be labor intensive and expensive - prohibitively so. Similarly, in urban areas, such as Fes, the traditional water management systems - based on the water distributor, in particular - was stopped due to the fact that the flow of the Oued Fes (which fed that distribution system) was considerably decreased following the construction of a large dam North of Fes, in the 1980s.

The choice of water management techniques therefore has important political impacts and the political dimension of water management in Morocco is explored in the next section of this chapter.

3. The politics of water management in Morocco

It is not rare to hear people talk of water as the new gold, or to associate the idea of having water as having power. Water security has grown as a major concern for the 21st century. In brief, who manages water inevitably has to deal with political issues. As Turton stressed, "Because water is scarce, and because it is essential for life, health and welfare, it has become a contested terrain and therefore a political issue" (Turton, 2002, p.9). In the literature, one talks of **hydropolitics** as "the authoritative allocation of values in society with respect to water". This definition implies the issue of **scale** (ranging from the individual, to

the household, village, city, social, provincial, national and international level with a number of undefined levels in between) and the **range of issues** that are covered (water conflicts and their mitigation, states and non-state actors, water service delivery, water for food, the social value of water, the political value of water, the psychological value of water, water demand management (WDM), water as a target of aggression, water as an instrument of peace, water and gender, ...). Including in the range of issues is the core place occupied by water in a specific type of development, as mediator between people and nature. The politics of scarce natural resource management offers a particularly interesting terrain of research in the context of both a *Muslim country* and a rise in *sustainable concerns*, as well as when attempting to **re-think the notion of economic development**. It is on these three aspects that I will be focusing next.

3.1 The evolution of water politics in Morocco: Towards 21st century 'new departures'?

Morocco is a Muslim country. Its King is the religious chief of 'his' believers, and the conduct of economic, social, political affairs all have to be in agreement with Islamic principles. In the context of environmental management, and with regards to water, in particular, this could and should present an advantage since water is so central to Islam. As Caroline Pestieau, then president of the International Development Research Centre, emphasised in her preface to Faruqui et al.'s book on Islam and water management, "since Islam is the religion of about one-fifth of the world's population and the official faith of a number of countries, in many of which water is the key scarce factor for development, understanding its actual or potential role is important" (in Faruqui et al, 2001, p.vii). Reminding ourselves of the Islamic principles related to water management is important in order to understand the present structure and functioning of water institutions in Morocco (Table 1).

This is because "the laws and rules governing the functioning of land and water uses in the country have actually emerged from the historical superimposition of three bodies of laws and rules: the *Orf* (customary sets of rules and admitted practices), the *Chraa* (religious interpretation of the Islamic law and rules) and the modern legislation introduced by the French protectorate and later reinforced by independent Morocco, since 1956" (Doukkali, 2005, p.75). When Islam was introduced to Morocco, the religious jurist (*Ulema*) accepted the very heterogeneous customary practices adapted to different physical milieu in the country. The only impact that the *Chraa* then had was to give some moral references that remained very theoretical and that didn't have real impact on the management of water resources. Lakes, groundwater and rivers, uncovered by customary laws, were at the time defined as public goods under the control of the sultan. At the beginning of the French Protectorate, in 1914, all surface waters were put under public domain following two arguments, as explained by Doukkali (2005). a) All waters were traditionally owned by central authority in Morocco. b) The concept of public domain was more in accordance with the true precepts of Islam. A state control over water was thus imposed by a protectorate very keen to manage the resources as it wanted. The conditions of water usage through irrigation and other purposes were described in a 1925 new legislation on water which strangled any private initiative on water development in the country.

The Protectorate also issued a law regarding water user associations to formalise and initiate the creation of an irrigation network. Three major rights systems were then in place (modern

registered rights over water, customary rights registered and customary rights un-registered).

<p>Social and spiritual dimensions of water</p>	<p>Water is considered a blessing from God that gives and sustains life and purifies humankind and the earth. Water is especially important for muslims for its use in <i>wudu</i> (ablution before praying) and <i>ghusl</i> (bathing).</p> <p>Equity: A Muslim cannot hoard excess water- he is obliged to allow others to benefit from it. The priority of water use rights is: first the right of humans to quench their thirst, second, the right of cattle and household animals and third the right of irrigation.</p> <p>In Islam, human-environment interactions are guided by the position of humans as <i>khulafa</i>, stewards of the earth.</p>
<p>Non economic instruments for water management</p>	<p>The Qu'ran states clearly that the supply of water is fixed and that it should not be wasted. Given the importance of cleanliness in Islam, and that many MENA countries have minimal waste water treatment, it is common to hear muslims declare that <i>waste water reuse</i> is undesirable or even haram (unlawful according to Islam).</p> <p>Family planning is allowable in Islam but should not be encouraged solely for material reasons. In many countries continued high population growth is severely stressing existing water resources and the environment. Family planning could help prevent further reductions in water availability of water per capita.</p>
<p>Economic instruments for water management</p>	<p>Economic measures over water usage are controversial in Muslim nations because of the Islam precept that water cannot be bought or sold. In Islam, water is considered the gift of God, so no individual literally owns it. According to Islam, a fair tariff will lead to equity across society. In endorsing fair markets, the prophet refused to fix prices for goods in the market, including water, except in special circumstances. Most Muslim scholars agree that a just price for water is that determined by the market, providing that the market is free from unfair practices.</p> <p>Economic practices also deal with intersectoral transfers of water, which will change radically in the next decades. Are intersectoral water markets allowable in Islam? As a population evolves from rural and agrarian to urban and industrial, reallocation is not only permissible but is required to preserve equity, and the primacy of the right to quench thirst. Intersectoral transfers are considered inevitable.</p>
<p>Integrated water management (IWM) at different levels</p>	<p>IWM should address all water resource management issues in relation to each other and to the water sector as a whole, with the goal of promoting equity, efficiency and sustainability. The water sector has many horizontal and vertical linkages and IWM needs to address micro and macro level decisions.</p> <p>Community based water management: The input of the community on matters that concerns it, including water management, is mandatory in Islam. This consultation is required of all of those who are entitled a voice - women too.</p> <p>National level: haddith command not to harm oneself and others, and the environment - hence encouraging an integrated approach that protects humans and nature.</p> <p>International levels: <i>Shura</i> (consultation on matters of mutual interest) and <i>fassad</i> (avoiding harm and damage) should be applied internationally.</p>

Table 1. How does Islam regards various approaches to water management - adapted from Faruqui et al. (2001)

The dominant concerns for resource protection inherent in the 1914 and 1925 laws gave place to the emerging economic requirements of the independent country after 1956, and the Moroccan 'policy of dams', centred on irrigated agriculture, emerged. The State got involved in large scale development works and, "for the purposes of balancing growth requirements and poverty concerns, agricultural development became an important component of the economic strategy since the mid-1960s and through the 1970s and the 1980s" (Doukkali, 2005, p.78). The increase in State intervention in the water sector was then based on the 1969 Agricultural Investment Code. Since the 1980s, the emerging macro-economic necessities and resource related constraints have prompted diverse types of water institutional reforms in Morocco.

3.1.1 The great institutional water reforms

In the 1980s, droughts provided an impressive impetus for changes in favour of a rapid expansion of private and groundwater based irrigation systems which, although they expanded or stabilised farm production, did it in the absence of effective regulatory arrangements and resulted in heavy aquifer depletion and in serious decline in the flow of several springs and watercourses that supported medium and small scale irrigation perimeters. The macro economic crisis of 1983 and subsequent economic liberalisation led to readjust agricultural institutions to allow them to cope with a market-oriented agricultural sector. The State decided to make the publicly managed large scale irrigation system more flexible and responsive to local needs. This involved the promotion and involvement of farmer organisations in water allocation and management through a revised legislation on Water Users Associations in 1990. WUAs were able to adjust positively but only in the context of small scale irrigation perimeters. In large scale irrigation perimeters, WUAs were still dependent on the State for funding and functioning. The revision of water pricing proved to depend on the involvement and empowerment given to the WUAs who refused to adhere to a 'full cost recovery' system they did not understand since they had had no say about the nature and make up of costs, nor in irrigation decisions.

Then, by the 1990s, there was little scope for further development of water resources through large scale schemes and the need to integrate surface and groundwater management became apparent. "The state was compelled to shift focus from water development and irrigated agriculture to the most difficult and challenging frontiers of water reallocation and integrated water resources management from the perspective of the whole economy" (Ait Kadi, 1998, in Doukkali, 2005, p. 83). The Water Law of 1995 was passed. It aimed at integrating and coordinating the allocation and management of all water resources and users under a single but decentralised institutional arrangement centred on river basin agencies (RBAs). De Miras and Le Tellier (2005) described the so called 'Loi 10-95' as "establishing the legal framework for the politics of water for the next decades and includes a number of legal instruments aimed at addressing the problems of decreasing reserves of water, increasing water demand, increasing water prices and the deterioration of water quality and the environment" (p. 222). As Doukkali explained (2005, p. 73), the 1995 Water law had also assigned top priority to the security of the drinkable water supply: by 1990, most urban households had been provided secure access to water supplies - whilst only 14% of rural households had secure water supplies. The RBAs still work with water sector partners (such as WUAs) and have authority to manage surface water storage and

allocation, groundwater pumping and water pollution and quality. Their main responsibility is to prepare river basin management plans that are respectful of IWRM principles and well integrated in the twenty year National Water Master Plan, as indicated by the national government through the heavy inputs it provides in such enterprises. As Doukkali explains, the RBAs have considerable managerial and regulatory responsibilities beside their role in developing and supplying water. They can monitor and regulate water use and quality as well as plan and organise flood control and water related emergencies within their respective basins. That third institutional phase, that of the 1990s, therefore changed once again the configuration of water actors on the national scene. It also changed it on the international scene, since it is at that point that the government of Morocco decided to significantly reorganise its water administration and to promote the private sector in water resource development and management. Thus, the concessions for water distribution in four large cities (Tangier, Casablanca, Rabat and Tetouan) were granted to private water companies, and the private sector involvement was also extended to the irrigation sector in 2002, encouraged by World Bank enthusiasts, through two projects – the construction of a transmission pipeline (Guerdane project) and a distribution network (the Gharb project).

In the urban context, political choices related to water management options are characterised by three main phases, as Haouès-Joune explains. The final phase of the Protectorate (1946-1953) was one during which the urbanism strategy was to ensure that the poorest communities could have access to urban services. In practice, that meant that efforts were put into providing services through infrastructures whose costs would be optimised. From the end of the 1970s, efforts were then put into identifying water tariffs that would be economically viable whilst still allowing the poorest communities to have access to water and water services. This was done in a context where the management and growth of accommodation was not well coordinated with the management of the water sector. Until the 1990s, water distribution was done both through 'régies' and through public services. To simplify, until the 1990s, the *institutional organisational* system, lead by the State, was as follows in the water sector (Allain-El Mansouri, 2005, p.166). Consultation bodies, such as the Superior Water and Climate Council, created in 1981, were aimed at coordinating the various actors in the water sector. *Administrative bodies* were originally represented by the Interior Ministry (through 'régies') and the Land, Environment and Water management Ministry. The creation of the Secretary of State for Water was aimed at illustrating the political will to prioritise water issues in the context of moves towards sustainable development strategies. At a local level, the directors of the 'agences de bassins' were in charge of implementing water policies imposed from above. *Public establishments* such as the ONEP (National Office in charge of drinkable water and régies) were in charge of the planning, production and provision of water in urban and rural centres and are autonomous financially. Finally, *local interventions* were undertaken by local collectivities and users associations.

Major changes took place in the 1990s with regards to political choices in the water sector. The risks of real water shortage had then increased in the country, together with the difficulties in meeting a growing demand for water because of the heavy expenditures associated with the equipment of new large scale infrastructures such as big dams, water transfers, water pollution treatment, and more extensive groundwater exploitation. The 1990s were marked by a desperate need to start saving water (water leakages were estimated to reach 40% of the resources provided), to improve water treatment and recycling, and to diminish the water infrastructure bills. Choices to be made were perceived as being technical

as well as socio-political. In practice, Morocco chose to manage the resource in a semi private, semi public way. This resulted in the State delegating water management and treatment as well as electricity provision to private companies. Thus, the Spanish consortium REDAL1 was put in charge of water distribution in Rabat, for instance. The *concession* is defined as a convention through which a public body gives the mission of exploiting a public service following certain conditions that are described in detail in a list of duties and requirements, and against a payment that, most of the time, comes from tax payers' money, to a 'concessionnaire' of its choice. This has been described as *gestion déléguée*. The resulting 'marketisation' of water in Morocco has been considered unsatisfactory, on two fronts. With current poverty levels, especially in urban environments, identifying appropriate water pricing has been a difficult problem to solve and the macro-economic situation a difficult terrain in which to integrate a natural resource market. The *gestion déléguée* therefore encountered a few hic ups, with REDAL1 being stopped after 3 years (instead of 30) and replaced by the great Veolia Environment. On a second front, politically speaking, this water management system has been far from operating in a participatory manner.

This is how the 1990s approaches led to the creation of the new Moroccan Environmental Charter.

3.1.2 The 'new environmental charter'

In these early decades of the twenty first century, Morocco seems to be focusing on a new political environmental strategy where its visibility in terms of environmental initiatives is of prime importance. In 2000, the King Hassan II Great World Water Prize, an international award, was jointly established by the Government of Morocco and the World Water Council, "in memory of his Majesty King Hassan II of Morocco's distinguished leadership and encouragement of cooperation and sound management of water resources". The Prize is to be awarded to an institution, organization, individual or group of individuals in honor of outstanding achievements in any aspects of water resources such as scientific, economic, technical, environmental, social, institutional, cultural or political.

The award is presented every three years in conjunction with the World Water Forum, during a special ceremony. The award winner receives a prize sum of US\$ 100,000, a trophy and a certificate. The theme for the Prize is "Cooperation and solidarity in the fields of management and development in water resources". The 4th edition of the King Hassan II Great World Water Prize will be held in Marseille in March 2012 during the 6th World Water Forum. Beside such grandiose initiatives, and maybe more importantly, a new Environmental Charter (together with the Fondation Mohamed VI pour la protection de l'environnement (<http://www.fm6e.org/fr/notre-fondation.html>) was announced in April 2010 and is aimed to provide a solid framework for all environmental laws, a 'de-facto constitution for environmental policy'. Amongst many of its targets are objectives to reduce external energy dependency and to ensure that half of energy usage comes from renewable energies (solar energy, use of methane from landfills, ...). The Charter also puts special attention to water management and, in particular, aims at increasing waste water recycling to more than 96%. As Slimani explains (2010, p.59, 60), Morocco is committing to a program costing 7 billion euros to improve the water treatment network and recycle used waters. All in all, the charter will thus provide proof that Morocco will sign up for a progressive policy to reconcile the imperatives of socio economic development with the preservation of the

environment and sustainable development'. Such a radical step, even if not fully accompanied by practical measures (yet), illustrates the wish of Mohamed the VIth and its government to approach development and economic issues in a more integrated and more independent way.

The new Environmental Charter thus emerged at a time when governance issues were being questioned and debated, and water management issues therefore found themselves linked to a whole new 'Moroccan environmental ethics'.

3.2 'New waves' in Moroccan water ethics

In previous sections, we explored how both the technical and political dimensions of water management in Morocco evolved throughout time. We saw that technical choices also had political dimensions. Here, we are going to examine the ethical implications that water politics can have.

Human dignity	There is no life without water and those to whom it is denied are denied life
Participation	All individuals, especially the poor, must be involved in water planning and management with gender and poverty issues recognized in fostering this process
Solidarity	Upstream and downstream interdependence within a watershed continually poses challenges for water management resulting in the need for an integrated water management approach
Human equality	All persons ought to be provided with the basic necessities of life on an equitable basis
Common Good	Water is a common good, and without proper water management human potential and dignity diminishes
Stewardship	Protection and careful use of water resources is needed for intergenerational and intra-generational equity and promotes the sustainable use of life-enabling ecosystems
Transparency and universal access to information	If data is not accessible in a form that can be understood, an opportunity will arise for an interested party to disadvantage others
Integrated Water Management (IWRM)	A means to ensure equitable, economically sound and environmentally sustainable management of water resources
Empowerment	The requirement to facilitate participation in planning and management means much more than to allow an opportunity for consultation. Best ethical practice will enable stakeholders to influence management
Inclusiveness	Water management policies must address the interests of all who live in a water catchment area. Minority interests must be protected as well as those of the poor and other disadvantaged sectors

Source: COMEST, 2004

Table 2. Principles of water ethical practices

First, what does **water ethics** mean? UNESCO previously examined that question through working group meetings organized under the auspices of the World Commission on the Ethics of Science and Technology (COMEST) and the International Hydrology Programme (IHP) in 1998 and published a report on Best Ethical Practice in Water Use (COMEST, 2004) which identified the fundamental principles presented in Table 2.

Morocco has been embracing, at least in political discourses, terms such as **ethics** and **integrated management** in the context of environmental and developmental strategies. Mohamed the VIth has been keen to show the world that his country was aligned to considerable international reflection on environmental ethics throughout the world and initiatives such as the adoption of the Universal Declaration of Bioethics and Human Rights (UDBHR) by all member countries of UNESCO in 2005.

Social and spiritual dimensions of water	Many people don't have access to water and still rely on expensive informal sources of water. The situation is inequitable and the primary water right under Islam is being compromised.
Non economic instruments for water management	<p>Policy-makers are beginning to appreciate the value of some haddiths with regards to water conservation and environmental education has been taking place in some mosques in the Middle East. The WHO launched health education programs through mosques in Afghanistan.</p> <p>Considering huge water constraints in the MENA area, waste water reuse in irrigation has been explored in view of ensuring that it was safe, not harmful to human health.</p>
Economic instruments for water management	<p>Supplying water almost free under today's conditions of polluted and scarce water supplies has resulted in severe inequities - the poor often pay immorally high prices for water in informal markets, or receive water of poor quality. Under changing conditions, Muslim leaders must adapt their water policies to meet timeless objectives such as social justice. Recovering costs for providing water is allowable in Islam - but what is a fair tariff?</p> <p>As a consensus in the rest of the world, private public partnerships are best recommended. If regulated markets are to be used then they must put in place legal, institutional and regulatory mechanisms to ensure that the markets operate fairly and efficiently. This includes developing better participatory processes.</p>
Integrated water management (IWM) at different levels	<p>Community level: In many Muslim countries, there is a very centralized decision-making system. Beside, decision-makers, often men, haven't invited wide participation. Changes have to accelerate and to happen at grassroots levels.</p> <p>National level: IWM that include principles such as equitable tariffs, environmental protection and food security need to integrate social policies sustained by grassroots inputs and discussed at national levels.</p> <p>International levels: there are currently many international water sharing disputes where states are not following the principles of shura or fassad. Legal agreements need to be reached.</p>

Source: adapted from Faruqui et al. (2001).

Table 3. Issues and recommendations on how to integrate Islamic principles in a new 21st century water ethics

The debates and international agreements on environmental and water ethics also encouraged a contemporary re-visit of Islamic principles used in the context of water management. Although it is clear that Islam generally advocates a fair distribution of water resources and a prioritization of usage, in practice there are currently a few issues that need adjusting for water management practices in a Muslim country like Morocco to be realigned with principles of water ethics (Table 3).

In addition to the alignment with international principles of water ethics and to Morocco's efforts to recreate links between modern water management and Islamic water management principles, the question of which type of 'economic development' to strategically embrace in order to help the country's development whilst generating people's participation to creating a sustainable economy is the central theme of this chapter. Politically, Morocco chose, after its independence, to base its economic development largely on natural resources – including agricultural – exports. Technology was one of its main tools in doing so. However, the creation of the new Environmental Charter as well as a new set of human and social reforms introduced by the King Mohamed the VIth at the beginning of the 21st century put the country in new 'tracks', in terms of a) how 'economic development' is being apprehended with regards to environmental protection and b) which actors could and/or should be involved in making 'sustainable development' happen. It is on these two aspects that I want to finish my reflection on the evolution of a water ethics in Morocco.

3.2.1 Ecological economics and human ecology: The role of water in alternative modes of 'development'

Earlier, we examined the political dimensions of water issues. Another crucial link exists between 'water issues' and 'economic development': water is needed in agricultural as well as industrial activities.

It is crucial to any type of production and to human life. It is also a much more complex, a more systemic type of natural resource than other natural resources that are used in economic activities in that, like air, it is indispensable to human life – without water, a human being will die in only 3 days. For this reason, human civilizations have valued water for all it brings to life: spiritual richness, a habitat for certain species, a support for navigation and for the generation of electricity, a crucial component of ecological cycles, a natural resource that can be directly consumed or that can contribute to the production of food, etc... Whilst 'economic development', in a mainstream neo-classical sense, will focus on the productive nature of water resources, alternative understandings of the term 'development', such as the ones introduced by disciplines such as ecological economics and human ecology (both preoccupied with the interactions between human economic systems and ecological systems functioning) will help in widening our understanding of 'development' and might help countries such as Morocco in dis-engaging themselves with old, quasi-colonial, styles of economic development, in order to enter the 21st century more innovatively and independently.

As Slimani explains (2010, p. 60), "Now that industrialized countries seem reluctant to fully engage, as the disappointing outcomes of the Copenhagen Summit on Climate Change in December 2009 have shown, Morocco's strategy constitutes a strong signal to developing countries. Instead of being an additional constraint, the environmental imperative could well be a new developmental tool and a stepping stone towards a stronger, at least more

sustainable, type of growth". Slimani's point is also reinforced by Tazi-Sadeq, Moroccan researcher specialized on water issue, who adds that "The diminishing supply and the increasing and ever more diversified demand in water entail a change of paradigm. This change has political and ethical implications having to do with efficient management - on the usage side - and fair distribution of water resources. It consists in placing water policies on the side of the demand and the human person at the centre of the debate" (Tazi Sadeq, 2005, p.13-15).

These reflections are in line with definitions of 'development' that include both ecological and human dimensions. COMEST, in particular, explain that "*development* can only take place if the people who are both its beneficiaries and its instrument also are its justification and its main objectives. Development must be integrated and harmonized. In other words, it must favour the complete development of human beings in spiritual, moral and material ways, hence ensuring people's dignity in society, in agreement with the Declaration of Human Rights" (COMEST, 2004, p.10).

If a country like Morocco is envisaging thinking about 'development' in more ecological and human ways, it is partly because it came to recognize the need for alternative models of development. Things are not fully working, big technical pushes, reforms, water pricing methods, have not been fully embraced and, worse, have led to uprisings that had been unseen in the past (we will come back to this in the next section). The so called Human Development approach arose in part as a result of growing criticism to the leading development approach of the 1980s, which presumed a close link between national economic growth and the expansion of individual human choices. The need for an alternative development model was then seen as being due to many factors, including:

- Growing evidence that did not support the then prevailing belief in the "trickle down" power of market forces to spread economic benefits and end poverty;
- The human costs of Structural Adjustment Programs became more apparent;
- Social ills (crime, weakening of social fabric, HIV/AIDS, pollution, etc.) were still spreading even in cases of strong and consistent economic growth;
- A wave of democratization in the early 90's raised hopes for people-centred models.

In Morocco, the human and ecological impacts of economic growth must also be stressed. As Leila Slimani (2010) explains, Morocco wants to use the protection of the environment as a central tool for development policies. For the last ten years, Morocco has experienced economic growth in all economic sectors: industrial, agricultural, tourism, urban development, infrastructures...These evolutions have had negative impacts on the environment. The Ministry of Trade and Industry estimated that environmental degradation costs 13 billion dirhams each year: 3,7% of its GNP (1.6 billion US dollars). Not only these costs are going to have direct consequences on the pace of developmental activities but they also impact lifestyle and the habitat of citizens. But the last point listed above (the democratization phenomenon) also resonated particularly loud and is motivating people to start thinking about development differently.

This is true both for internal reasons (Mohamed the VIth made a point of initiating social reforms in his country from the moment he replaced his - much more authoritarian - father) and international reasons (Foreign investors favor democratic regimes). Thus, on top of wanting to set an example to other countries and describing the Charter for the

Environment as leading the Arab and African nations in becoming more energy dependent via their renewable energy sources, hence deciding to use the charter as a 'blueprint' for other countries to follow as a collective, homogenised set of initiatives to fight climate change, Mohamed the VIth developed the concept of 'proximity' by inviting his citizens to participate in the writing of the Charter through an online consultative process, between January and February 2010 (Slimani, L. 2010, p. 59).

However, an *online, one month*-long consultative process might not have been enough for people to feel they could genuinely participate and be heard. And so, as the next section shows, there is still a long way to go in order to refine the new Moroccan vision of water ethics and governance, and to make it work.

3.2.2 Alternative environmental governance or 'Watering' the 'Printemps Maghrébin'

The Commission Mondiale d'Ethique des connaissances Scientifiques et des Technologies, COMEST (the World Commission on Ethics, Scientific knowledge and technology) was still considering the debate on governance (in particular water governance) as relatively new, in 2004. It explained that "In general, governance is defined by the ways in which traditions and institutions allow to balance power in the running of a country. Water governance", it stressed, "deals with levels of governance where reality takes over theory. Good governance means that a genuine dialogue takes place. It allows people to define or re-define good shared principles, rights and responsibilities in view of improving the co-ordination of all involved parties, and stimulating development" (COMEST, 2004, p.8). In Morocco, a lot of shortcomings existing in the legal system as well as problems related to the lack of official recognition of certain rights, will have to be addressed if new modes of environmental governance are to really exist. Problems related to the 1995 water law were, for instance, illustrated by Boukhima (2009) who explained that the unrealistic financial conditions set by the law (payment of high fees to get the permission to drill a well, notably) had led to all sorts of illegal, de-regulated and ecologically destructive digging of wells by Syrian enterprises in the area of Souss-Massa-Darâa where the annual water deficit had already reached 233 million cubic meters. Similarly, economic and financial options taken by the Moroccan government in favour of the 'gestion déléguée' (private-public partnership) has been highly criticised and has been the object of numerous demonstrations. The right to accessing water is being jeopardised by current practices in favour of privatization and water pricing, and Non Governmental Organisations such as the ACME have been expressing their dissatisfaction and communicating the views of the Moroccan population, especially its wish to make water management more communal, since 'water is a common good that should not be privatized in any way, as well as the need to include the right to access water in a new constitution.

Moroccan researcher Tazi-Sadeq spent relentless efforts defending the human right to access water and sanitation services, and has done so in an official context, from a UNESCO office in Rabat. As she put it, "The right to water emerges as a concept around which changes and reconciliations can crystallise. It is necessary to reconcile economy and ecology over water. But this vital resource calls for other reconciliations. It makes it necessary to remedy different inequalities, to create an international legal and institutional framework followed at the level of states – first guarantors of effective access to water – and establish links between local and global action. Each of these changes represents an argument in favour of

the promotion and proclamation of the right to water. The right to safe water would make it possible to ensure access to water without discrimination, in a sustainable and enduring manner and at a cost that is socially and economically acceptable; to avoid its becoming a threat to the environment, to aquatic systems, to health, to peace and security; to determine responsibilities; to put in place an effective governance and define its operation modes at the international, national and local levels; to mobilise necessary resources, coordinate partnerships and organise cooperation and solidarity" (Tazi Sadeq, 2005, p.13-15).

Other Moroccan stakeholders, such as numerous NGOs and, in particular, ACME-Maroc (Association for the world contract on water), are functioning in more participatory ways and communicating equally important messages, if more practically demanding, when it comes to political and institutional changes. Thus, the ACME for instance demanded that a public enquiry should be conducted - by the Parliament and the legal profession - to determine in which conditions, and in exchange of what, the decision to delegate the management and distribution of water, sanitation and electricity to private enterprises had been taken. It also demanded the re-opening of enquiries from anti-corruption instances because it suspected that the creation of delegated water management contracts had been corrupted and illegal in their applications. As a very active and militant association (NGO), it somehow characterises what many other NGOs are doing in Morocco - creating an alternative system of governance and expression by the people, calling for more justice and participative processes, demanding more recognition. The ACME approached issues of

Considering that:

- a. the constitution of a democratic State must take citizen's fundamental rights into account
- b. the right to life is the most fundamental of human rights
- c. the right to life depends on access to water
- d. water is part of nature, essential to life
- e. water must be considered as a common good, shared by the national community
- f. Morocco has adopted in 1995 a Water Law, considering water as a common good, and because this Law must be promoted to a higher level in our legal system (Dahir n° 1-95-154 du 18 rabii I 1416 -16th of august 1995)
- g. the adoption of the UN resolution 64/292 on the 28th of July 2010 that declares that the right to access water and sanitation is a human right - resolution which Morocco officially signed
- h. the adoption of the UN resolution A/HRC/15/L.14 of the Council of Human rights on the 24th of September 2010, re-asserting the right of humans to have access to water and sanitation
- i. certain States have already included the right to water and sanitation in their constitutions - for instance Bolivia, Venezuela, Uruguay, Nigeria..
- j. ACME-Morocco demands that the right to access water and sanitation should be included in the Moroccan constitution as well as the notion of water as 'common good', property of the whole national community and protected by it and for it, with a priority given to meeting the water domestic needs.

Box 1. ACME's demand to include water rights in the Moroccan constitution

water management from an educational angle, considering that environmental awareness and communication with communities will be needed if these are to take part in the implementation of sustainable development principles. In doing so, it showed its alignment with international initiatives such as the International decade of education for sustainable development 2005-2014. It also organized projects with women in rural communities. More recently, it also officially requested the inclusion of the right to access water and sanitation in a new constitution (Box 1).

The introduction of new 'voices' in the water decision-making process is both encouraged (through participatory principles concepts advocated in the new environmental charter) and feared by authorities used to hold the reins and relatively unfamiliar with democratic and human-scale development practices they are wishing to bring back into place. Morocco is currently experiencing, through its prolonged 'spring', a change in governance which, for the first time, also includes environmental considerations and re-link people to their land (and their water). This is a true 'revolution' in an 'ecological economics' sense of the term which, although it is only the beginning, could provide fascinating alternative modes of water governance - provided that the authorities dare listen to the various successful initiatives currently being undertaken to prove that modern and traditional can be happily reconciled in order to re-understand which practices work well for the Moroccan citizen and for the country. Such initiatives include efforts by the architect Aziza Chaouni (Aga Khan prize of architecture), who is working on the re-introduction of sustainable water management principles in the rehabilitation of the medina of Fes and people working on integrated forest and water management, or again efforts by numerous environmental NGOs to educate rural and urban populations in view of re-energizing their wish to value the natural resources they depend on and they used to know how to protect.

4. Conclusion

Through a reflection on the evolution towards a new water ethics in Morocco, this chapter has attempted to explore the practical ecological, technical, and political implications of trying to put into practice concepts such as 'Integrated, sustainable, water management' for a developing, Muslim country. I started by describing the physical constraints this North African country has to deal with, its aridity and the irregularity in precipitation that make finding appropriate and locally adapted water policies a - difficult - necessity. I then gave a few examples of how traditional water management systems used to (and still do, in some regions) deal with water shortages and potential water conflicts, both in rural and in urban environments. I then explained how the French Protectorate, followed by the independence of the country, provided a new uneasy framework (of land tenure and water prioritization) that seemed to both go 'against the tide' (in terms of social structures and geographical specificities) but also open the door to 'modernisation' and economic development, a realm that the newly independent country was keen to embrace. Institutional reforms, new water laws and the creation of new stakeholders (water users associations, etc.) constituted a set of initiatives that intertwined with time and resulted in an emerging and growing need and wish to function within a new developmental and more environmentally friendly paradigm. This new paradigm includes notions such as participation, democratisation, decentralisation, integrated water management (Box 2), environmental charters and laws, ... Through its new 'green approach', the king of Morocco is both keen to be internationally perceived as respectful of 'green initiatives' undertaken worldwide - Morocco took part in

the World Environmental Summit in Rio in 1992 – and to show his people that he is hearing its requests and needs (numerous demonstrations followed the famous 20th of February 2011).

Principle 1: Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment.

Principle 2: Water management should be based on a participatory approach, involving users and policy-makers at all levels.

Principle 3: Women play a central part in the provision, management and safeguarding of water. In order to ensure full and effective participation of women at all levels of decision making, account should be taken of approaches that public agencies use to assign social, economic and cultural functions to men and women.

Principle 4: Water is a public good and has a social and economic value in all its competing uses.

Principle 5: Integrated water resources management is based on the equitable and efficient management and sustainable use of water. The real challenge with IWM is to find ways of integrating various policy tools in a socially, politically, economically and ethically acceptable way.

Box 2. Dublin principles presented at Rio and from which the notion of IWM is based

But the 'Printemps Maghrébin', in Morocco, will certainly experience a few seasons. For if the notion of development is being currently challenged, economic pressures are still high and often influence the choice of water technologies and policies that are not yet appropriately participatory nor ecologically sustainable. In order for water management in Morocco to become more humanly and ecologically sustainable, a stronger respect for and re-visit of traditional practices as well as a thorough exploration of the following definition of sustainable development will be needed. As Allan explains, (2002, in Turton and Henwood (eds), p.25) "Sustainable water policies are not achieved through the adoption of sound environmental principles alone. Nor are they achieved by efficient water use based on principles of economic efficiency. Sustainable water use is achieved in the political arena. National hydropolitics is a mediating discourse. The voices of society, the economy and the environment impose their often conflicting priorities and demands on the national water resource". Similarly, a stronger confidence in the cultural potential of the country's environmental practices could help in re-defining the type of 'development' that Morocco is keen to pursue. As UNESCO reports on 'creative cultural diversity in the world' put it, "development efforts often fail because the importance of the human factor – that complex web of relationships, beliefs, values and motivations which lie at the very heart of a culture – is being underestimated in many development projects. (...) Development cannot be seen as a single, uniform, linear path, for this would eliminate cultural diversity and experimentation, and dangerously limit humankind's creative capacities in the face of a treasured past and an unpredictable future" (Perez de Cuellar, 1996, p.7).

To be developed is not to have more, but to be more **Ghandi**

5. References

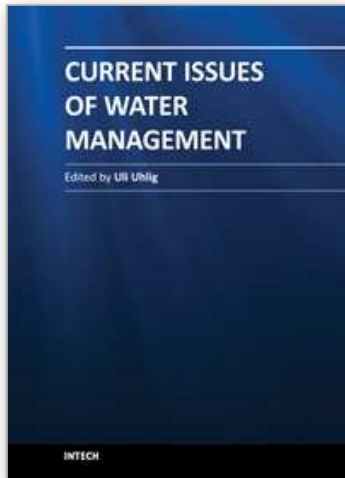
ACME [http:// www.acme-eau.org/ACMEMaroc/index.php](http://www.acme-eau.org/ACMEMaroc/index.php)

African proverbs from

<http://www.special-dictionary.com/proverbs/keywords/water/23.htm>

- Agoumi, A. (2005). La vulnérabilité hydrique du Maroc face aux changements climatiques. La nécessité de stratégies d'adaptation. Objectifterre Special Changements Climatiques (Novembre 2005), pp.36-37, Agence intergouvernementale de la francophonie, Paris, France
- Ait Kadi, M. (1998). Water sector development through effective policies, institutions and investment: a country perspective, Paper for workshop 3, international Conference on Water and Sustainable Development, Paris, March 1998
- Allain-El Mansuri, B. (2005). La délégation au secteur privé de la gestion de l'eau potable au Maroc : le cas de Rabat-Salé. P. 163-189. In De Miras, C. (ed) *Intégration à la ville et services urbains au Maroc*. IRD, Paris.
- Allan, T. (2002). Water resources in semi-arid regions: Real deficits and economically invisible and politically silent solutions, In *Hydropolitics in the developing world*, A. Turton and R. Henwood (Eds), pp. 23-36, African Water Issues Research unit, ISBN 0-620-29519-8, Pretoria, South Africa
- Bennis, A: and H: Tazi-Sadeq (1998). Population and Irrigation Water Management: General Data and Case Studies, in de Sherbinin, A. and V. Dompka (eds) *Water and population dynamics. Case studies and policy implications*. IUCN, AAAS. <http://www.aaas.org/international/ehn/waterpop/morroc.htm>
- Boukhima, A. (2009). Irrigation, les pilleurs d'eau, In *Focus, EcoPlus* (December), p.26, 27
- COMEST (Commission mondiale d'Ethique des Connaissances Scientifiques et des Technologies) (2004). *L'eau et la gouvernance : Meilleures pratiques éthiques*. UNESCO, Paris, France. Available from www.unesco.org/shs/ethics
- Crouch, D.P. and Johnson, J.G. (2001). *Traditions in Architecture*, Oxford University Press, ISBN -10: 9780195088915 Oxford, United Kingdom
- De Miras, C. and Le Tellier, J. (2005). Le modèle Marocain d'accès à l'eau potable et à l'assainissement. Casablanca et Tanger-Tétouan; La gestion déléguée, entre régulation sociale et marchandisation, In de Miras, C. (Ed) *Intégration à la ville et services urbains au Maroc*. Institut de Recherche pour le Développement, Paris, France pp.219-254
- Doukkali, M.R. (2005). Water institutional reforms in Morocco. *Water Policy*, Vol.7, No.1, pp.71-88, ISSN 1366-7017
- Et Tobi, M. (2003). Histoire d'eau. Pour une stratégie de gestion de secteurs naturellement liés: les ressources hydriques et les ressources forestières, in *L'Opinion* (janvier), p.6,7.
- Faruqui, N.I.; Biswas, A.K. & Bino, M.J. (2001). *Water Management in Islam*, International Development Research Centre, ISBN 0-88936-924-0, Ottawa, Canada
- Global Water Partnership <http://www.gwp.org/The-Challenge/What-is-IWRM/Dublin-Rio-Principles/>
- Haouès-Jouve, S. (2005). L'accès au grand nombre aux services urbains essentiels. L'expérience casablancaise dans le long terme, entre ruptures et continuités. In de Miras, C. (Ed) *Intégration à la ville et services urbains au Maroc*. Institut de Recherche pour le Développement, Paris, France pp. 191-217
- Jellali, M. and Geannah, M. (1998). La gestion décentralisée de l'eau au Maroc. Situation actuelle et perspectives. *Proceedings of the International Conference 'Eau et Développement durable'*, Paris, 19-21 March 1998

- Lightfoot, D.R. (1996). Moroccan ketarras: traditional irrigation and progressive desiccation. *Geoforum*, Vol.27, No. 2, (May 1996), pp.261-273, ISSN 0016-7185
- Mahfoud, L. (2011). Stratégie de l'eau: anticiper la pénurie. *Pertinences*. Maroc Vert An III, Numero 8 (May), pp. 52-54, ISSN 1114-8772
- Mernissi, F. (1997). *Les Ait Débrouille du Haut Atlas*, Le Fénnec, Casablanca, Maroc.
- Michell, G. (1995). *Architecture of the Islamic World. Its history and social meaning*, ISBN 9780500278475 Thames and Hudson, London, United Kingdom.
- Pascon, P. (1978). De l'eau du ciel à l'eau d'Etat . *Psychosociologie de l'irrigation*. HTE , no. 28, sept, p.3-10.
- Pérennès, J. (1993). *L'eau et les homes au Maghreb. Contribution à une politique de l'eau en Méditerranée*, Karthala, ISBN 2-86537-357-6, Paris, France
- Perez de Cuellar, J. (1996). *Our creative diversity, Report of the World Commission on Culture and Development*. UNESCO, Paris, France.. *Des airs, des eaux, des lieux : Fes, capitale thermale*. APS, Tours, France.
- Secret, E. (1990). Les sept printemps de Fes
- Serrhini, F. (2003). L'eau à Fès, symbole d'une civilisation urbaine. *Revue H.T.E.*, No.26 (Juin 2003), Fes, Maroc
- Sibley, M. (2006). The historic hammams of Damascus and Fez : lessons of sustainability and future developments, 23rd Conference on Passive and Low Energy Architecture, Geneva, Switzerland, 6-8 September 2006
- Slimani, L. (2010) Environnement une place au soleil, *Jeune Afrique*, No2570, pp. 58-60
- Swearingen, W. D. (1987). Moroccan mirages : agrarian dreams and deceptions, 1912-1980, Princeton, Princeton University Press, USA.
- Tazi Sadeq, H. (2005). For an effective right to water. *The Green Cross OPTIMIST*, Winter 2005, p.13-15, Available from <http://www.greencrossinternationale.net>
- Turton, A. (2002). Hydropolitics: The concept and its limitations, In *Hydropolitics in the developing world*, A. Turton and R. Henwood (Eds), pp. 13-22, African Water Issues Research unit, ISBN 0-620-29519-8, Pretoria, South Africa
- UNESCO (2005). *United Nations Decade of Education for Sustainable Development (2005-2014): International Implementation Scheme*. Technical paper ED/DESD/2005/PI/01. UNESCO Education Sector, Paris.
- Van Dijck, S.J.E. et al. (2006). Desertification in Northern Morocco due to the effects of climate change on groundwater recharge, In *Desertification in the Mediterranean region. A Security Issue*, W.G. Kepner, J.L. Rubio, D.A. Mouat and F. Pedrazzani (Eds), chapter 26. ISBN 9781402037603, Springer, Netherlands.
- Wines, J. (2000). *Green architecture, The Art of Architecture in the Age of Ecology* Taschen, London
- Wolf, A. (2000). Indigenous approaches to water conflict resolution and implications for international waters. *International Negotiations, a Journal of Theory and Practice*, Vol.5, No.2, (December 2000), pp.357-373 Available at <http://www.transboundarywaters.orst.edu/publications/indigenous/>



Current Issues of Water Management

Edited by Dr. Uli Uhlig

ISBN 978-953-307-413-9

Hard cover, 340 pages

Publisher InTech

Published online 02, December, 2011

Published in print edition December, 2011

There is an estimated 1.4 billion km³ of water in the world but only approximately three percent (39 million km³) of it is available as fresh water. Moreover, most of this fresh water is found as ice in the arctic regions, deep groundwater or atmospheric water. Since water is the source of life and essential for all life on the planet, the use of this resource is a highly important issue. "Water management" is the general term used to describe all the activities that manage the optimum use of the world's water resources. However, only a few percent of the fresh water available can be subjected to water management. It is still an enormous amount, but what's unique about water is that unlike other resources, it is irreplaceable. This book provides a general overview of various topics within water management from all over the world. The topics range from politics, current models for water resource management of rivers and reservoirs to issues related to agriculture. Water quality problems, the development of water demand and water pricing are also addressed. The collection of contributions from outstanding scientists and experts provides detailed information about different topics and gives a general overview of the current issues in water management. The book covers a wide range of current issues, reflecting on current problems and demonstrating the complexity of water management.

How to reference

In order to correctly reference this scholarly work, feel free to copy and paste the following:

Sandrine Simon (2011). From Traditional to Modern Water Management Systems; Reflection on the Evolution of a 'Water Ethic' in Semi-Arid Morocco, Current Issues of Water Management, Dr. Uli Uhlig (Ed.), ISBN: 978-953-307-413-9, InTech, Available from: <http://www.intechopen.com/books/current-issues-of-water-management/from-traditional-to-modern-water-management-systems-reflection-on-the-evolution-of-a-water-ethic-in->

INTECH
open science | open minds

InTech Europe

University Campus STeP Ri
Slavka Krautzeka 83/A
51000 Rijeka, Croatia
Phone: +385 (51) 770 447
Fax: +385 (51) 686 166
www.intechopen.com

InTech China

Unit 405, Office Block, Hotel Equatorial Shanghai
No.65, Yan An Road (West), Shanghai, 200040, China
中国上海市延安西路65号上海国际贵都大饭店办公楼405单元
Phone: +86-21-62489820
Fax: +86-21-62489821

© 2011 The Author(s). Licensee IntechOpen. This is an open access article distributed under the terms of the [Creative Commons Attribution 3.0 License](#), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

IntechOpen

IntechOpen