Reflexive Water Management in Arid Regions: The Case of Iran

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ABSTRACT

To illuminate the problems and perspectives of water management in Iran and comparable (semi-) arid Middle East and North Africa (MENA) countries, three paradigms can be distinguished: the traditional, the industrial and the reflexive paradigm. Each paradigm is characterised by its key technical system, its main social institution and its ethico-religious framework. Iran seems to be in a state of transition from the 'hydraulic mission' of industrial modernity to a more reflexive approach to water management. This article sketches the contours of the emerging paradigm: a complementary system of traditional and modern methods of water provision, a participatory water resources management and a 'post-mechanistic' ethico-religious framework.

KEYWORDS

Water, *Qanat* irrigation system, industrial modernity

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1. INTRODUCTION

Today, there is a broad consensus that we are facing a growing global water crisis. Not surprisingly, there is less consensus with respect to the question of the causes and consequences of this crisis. Most people seem to be convinced that the main cause of the water crisis is water shortage or water stress, resulting from population pressures coupled with industrialisation and urbanisation, and, more recently, with global climate change and the disastrous combination of lower precipitation and higher evaporation. While the world's population tripled in the twentieth century, water use has grown six-fold. This massive rise in the consumption of water, which went hand in hand with an increase in the contamination of this finite resource, was made possible by relatively recent technological advances in dam-building, well-drilling and pump technology. Consequently, people who attribute the global water crisis to water scarcity primarily look for technical solutions, and promote the design and development of more adequate or appropriate technologies like desalination, drip irrigation, rain water capture and storage, and water-free toilets.

There is, however, a growing number of people, who do not attribute the global water crisis merely to the growing scarcity of finite water resources, but mainly to 'a crisis in governance', as was declared at the Second World Water Forum of 2000 in The Hague. The very same year, the World Water Council made the following statement: 'There is a water crisis today. But the crisis is not about having too little water to satisfy our needs. It is a crisis of managing water so badly that billions of people – and the environment – suffer badly' (Cosgrove and Rijsberman, 2000: xix). In his keynote address at the Fourth World Water Forum of 2006 in Mexico, HRH Prince of Orange Willem-Alexander of The Netherlands also highlighted the fact that the water crisis is in fact a management crisis (WWF, 2000: 16). The second edition of the UN's World Water Development Report from 2006 likewise claimed that the water crisis is one of water governance, essentially caused by the ways in which we mismanage water, and outlined many of the leading obstacles to sound and sustainable water management: sector fragmentation, poverty, corruption, stagnated budgets, declining levels of development assistance and investment in the water sector, inadequate institutions and limited stakeholder participation.

Yet another group of people, among whom are many environmental philosophers, wag their fingers at our unsustainable and 'water-intensive' lifestyles. Globally, consumption preferences and patterns show an increasing desire and demand for products that require large amounts of water. Water consumption is also bound to increase as long as people are not facing water scarcity directly and physically, and believe that access to water is an obvious and natural thing.

While the first group of people stresses the – partially technologically induced – scarcity and shortages of our limited water resources, and the second group focuses on unsound governance and mismanagement, the third group draws our attention to public perceptions and preferences. There is, however, growing awareness among environmental social scientists that every single one of these perspectives is important and relevant for sustainable solutions to the global water crisis. But these different perspectives should not be treated separately, these scientists claim, because technological developments, governance regimes and personal belief systems and lifestyles are strongly interconnected.

A recent collection of papers from environmental social scientists who examine the ways that technology, governance and people shape each other is Joseph Murphy's edited book, entitled *Governing Technology for Sustainability* (2007). In this book, the challenge of sustainable development is explored by 'rethinking the relationship between people, technology and governance. In fact, understanding and recasting the people-technology-governance nexus might be two of the most important challenges associated with sustainable development' (Murphy, 2007: 207).

> This nexus is a web of relationships, with each element constantly reproducing or reshaping the other two. Governance for example, leads to strategic decisions about technology, based in part on assumptions about people. At the same time, however people can resist those assumptions and the way they are used to justify some technologies and not others. (ibid.: 217)

We will use this framework – the people-technology-governance nexus – to explore and examine the problems and possibilities of a transition to sustainable water management in Iran. The main challenge confronting Iran is how to continue the expansion of food production to meet future demand without imposing negative effects on the environment.[1] Since the country has a long history of agriculture, its inhabitants have already occupied almost all the fertile land. In recent times, however, there has been a slight increase in the total area under cultivation. This was achieved by bringing under cultivation the barren lands that have only a marginal agricultural potential. A comparison of the 1973 and the 1998 agricultural censuses shows that in a quarter of a century only 483,000 ha of new land was brought under cultivation, 2.8 per cent of the total. On the other hand, the negative water balance[2] implies that no more new land can be brought under cultivation, and that the country is already facing a critical situation regarding the management of water resources and sustainable food production in existing cultivated lands.

The case of Iran is also relevant for other countries of the Middle East and North Africa (MENA) region, which not only have similar (arid and semi-arid) environments, but also, to a large extent, share the same religion and history. The transition to sustainable water management is especially urgent for this region, because data from a major report published on 11 March 2007 by the World Bank shows that all countries in the region are facing a severe water crisis. Nearly 80 per cent of all precipitation in the region is used, compared with only two per cent in such regions as Latin America, the Caribbean and Sub-Saharan Africa. The water crisis is expected to get worse in light of high population growth and climate change. In fact, it is estimated that per capita water availability in the region will fall by half by 2050.

To address the challenge of sustainable development, we will focus on the transition from industrial modernity to what sociologists like Ulrich Beck, Anthony Giddens and Scott Lash (1994) have called 'reflexive' modernity. Reflexive modernity does not indicate a break with modernity, but stands for a radicalisation within modernity – a 'modernisation of modernity'. An important aspect of this 'second order' modernity is the reevaluation and rehabilitation of tradition. That is why we will start with a description of the pre-modern technology-governance-people water nexus. Instead of water nexus we prefer to use the term 'water paradigm', from Tony Allan (2006).

The traditional or pre-modern water paradigm can by characterised by its key technical system (the *Qanat* system of underground irrigation channels), its main governance institution (the *Buneh* cooperative organisation of agricultural production) and its ethico-religious belief system (Zoroastrianism and Islam) (section 2). The current paradigm of industrial modernity can be identified by the partial replacement of *Qanats* by deep wells and large dams, the substitution of the *Buneh* by a system of smallholding, and the emergence of a mechanistic worldview with important ethical ramifications (section 3). In the North, since the 1960s and the 1970s, industrial modernity has gradually given way to what has come to be known as reflexive or second modernity. The paradigm of reflexive modernity can be characterised (1) by the integration of traditional (indigenous, small scale) and modern (scientific, large scale) technological infrastructure, (2) by participatory water resources management in the form of multi-stakeholder platforms or water user associations, and (3) by its recognition of the diversity of cultural values of water (section 4). We will conclude our paper with a sketch of what we consider to be the main contours of reflexive water resources management in Iran and other countries of the MENA region (section 5).

2. TRADITIONAL WATER MANAGEMENT

The Qanat irrigation system – a brief history

More than 3000 years ago, the inhabitants of the dry, mountainous regions of Iran perfected a system for conducting snowmelt through underground channels, the so-called *Qanat*, which began in the mountains and carried water downwards to the plains by gravity, to farms, country gardens and towns (Foltz, 2002). The conduits – which are usually 50 to 80 centimetres wide and 90 centimetres to 1.5 metres high – vary between several hundred metres to more than 100 kilometres in length. In Iran alone, there are some 22,000 of them, comprising more than 273,500 kilometres of underground channels.

The *Qanat* irrigation system rests on indigenous knowledge and experimental hydrology. It was widely used for several reasons. First, unlike other traditional irrigation devices, such as the counterpoised sweep, *Qanats* require no power source other than gravity to maintain a flow of water. Second, water

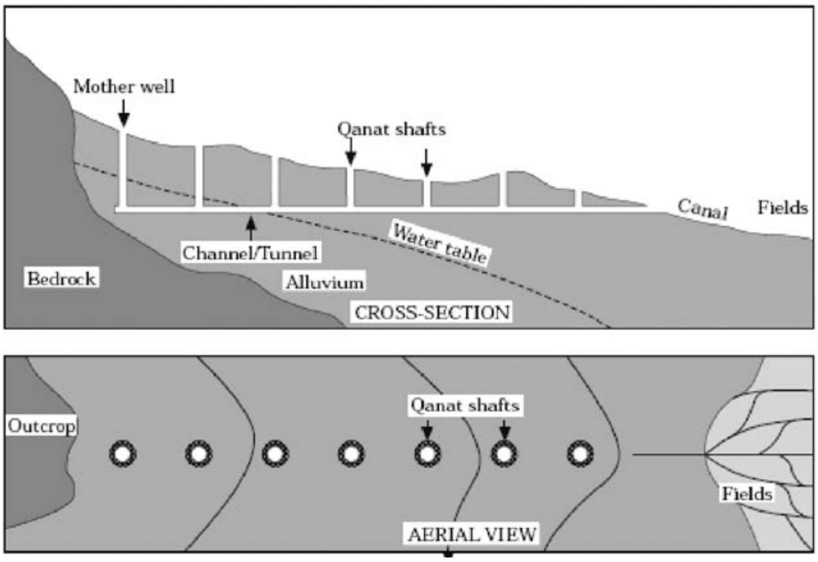

FIGURE 1. Qanat irrigation system (Lightfoot, 1996).

can be moved over substantial distances through these subterranean channels with minimal evaporation losses and little danger of pollution. Finally, the flow of water in a *Qanat* is proportionate to the available supply in the aquifer and, if properly maintained, these irrigation canals could provide a reliable supply of water for centuries (Haeri, 2006).

Qanats are built by specialists called *muqanni* (*Qanat* diggers), who transmit their knowledge from father to son. A windlass is set up at the surface and the excavated soil is then hauled up in leather buckets. A vertical shaft of about three feet in diameter is dug out, one man working with a mattock and the other with a short-handled spade. A gently sloping tunnel is thus constructed which conducts water from an infiltration section beneath the water table to the ground surface by gravity flow.

The *Qanat* works were built on a scale that rivalled the great aqueducts of the Roman Empire, but, whereas the Roman aqueducts now are only of historical interest, the *Qanat* system is still in use after 3000 years. The advantage of the *Qanats* over the Roman open air aqueducts is that less water is lost by evaporation on the way from hill to plain.

There is little doubt that ancient Iran (Persia) was the birthplace of the *Qanat*. Greek historian Polybius credits the Achaemenids (550 to 331 B.C.) for bringing water to remote areas throughout the Persian Empire through the use of *Qanats*. The Achaemenid rulers provided a major incentive for *Qanat* builders and their heirs by allowing them to retain the profits from newly-constructed *Qanats* for five generations. As a result of this water supply, thousands of new settlements were established and others expanded.[3]

Three centuries later, when the Parthians invaded Iran, *Qanats* were in widespread use on the Iranian plateau. To the west, *Qanats* were constructed from Mesopotamia to the shores of the Mediterranean, as well as southward into parts of Egypt and Arabia. To the east of Iran, *Qanats* came into use in Afghanistan, the Silk Road oases settlements of Central Asia, and the Chinese province of Sinkiang (now Xinjiang) (English, 1997).

During the Roman-Byzantine era (64 B.C. to A.D 660), many *Qanats* were constructed in Syria and Jordan. From here, the technology appears to have diffused north and west into Europe. There is evidence of Roman *Qanats* as far away as the Luxembourg area.

The expansion of Islam initiated another major diffusion of *Qanat* technology. The early Arab invasions spread *Qanats* across North Africa into Spain, Cyprus and the Canary Islands. Finally, evidence of New World *Qanats* can be found in western Mexico, in the Atacama regions of Peru, and Chile at Nazca and Pica. The *Qanat* systems of Mexico came into use after the Spanish conquest.[4]

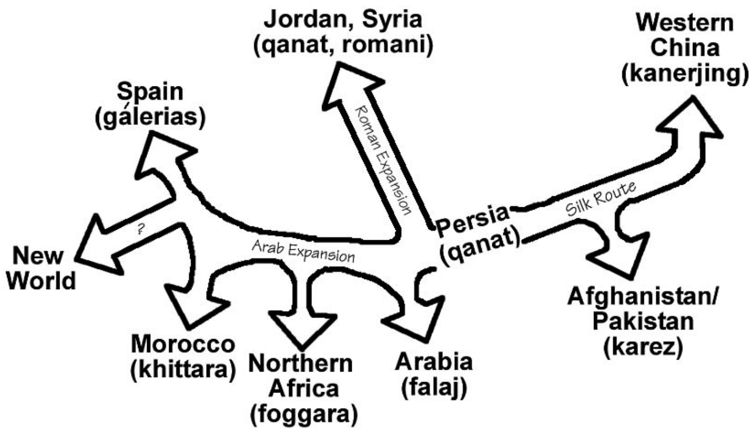

FIGURE 2. Qanat technology diffusion (Qanat, waterhistory.org).

Buneh – the Qanat system as a socio-technical system

Technological systems cannot be separated from the human activities and social institutions that make them work. In other words, technology is part of a nexus that also includes governance. The *Qanat* system is a socio-technical system. It is not only an engineering wonder, but also a remarkable social phenomenon. *Qanats* reflect collective and cooperative work. Because individual peasants possessed neither the capital nor the manpower that was needed for construction and maintenance of the *Qanat* system, independent production was at a disadvantage compared to other systems of production such as the multi-family collective or the *Buneh* in Iran. The major function of the *Buneh* was the efficient exploitation of productive land and the careful use of scarce water resources. Although *Buneh* had some disadvantages (e.g., an internal unequal division of labour and crop), it strengthened the socio-economic position of the peasants (Lahsaeizadeh, 1993).

Basically, each *Buneh* has six main members. It was under the charge of one peasant known as the *sarBuneh* (*Buneh* head) or *abyar* (Irrigator). He was chosen by the landowner or his bailiff. Experience and expertise in agricultural affairs were necessary qualifications for the *sarBuneh or abyar*. Each *sarBuneh* had two assistants, known as *varBuneh*, chosen by the *sarBuneh* from among his friends and relatives. Finally, sharecroppers formed the foundation of a *Buneh* structure.

At the beginning of each agricultural year, all the *sarBunehs* of the village gathered to decide how the fields should be distributed among *Bunehs*. Once these basic decisions had been made, the important tasks of each *sarBuneh* included marking off the boundaries of his *Buneh*'s field and plots, determining the type of crop for each plot, assigning tasks for each member, coordinating irrigation, sowing seed, contracting seasonal workers, supervising threshing the grain, controlling the division of crops, and, finally mediating between the *Buneh*'s members and the landlord.

The *Buneh* also included some groups others than peasants. The first group consisted of those craftsmen who worked directly for the *Buneh*. Members of this group included *muqanni* (well and *Qanat* diggers), *ahangar* (blacksmith) and *najjar* (carpenter). They were paid in kind at harvest time and carried out repairs for the *Buneh* throughout the year. The second group included barbers and bath keepers. Members of the *Buneh* were allowed to go to the public bath regularly without payment during one agricultural year. Also, the village barber went to the *Buneh* field weekly and cut *Buneh* members' hair and shaved their beards free of charge. In return, both bath keepers and barbers received a share of the crop at harvest time. Finally, each *Buneh* needed some extra hands during harvest time. For this purpose, daily wage labourers were hired. They were temporarily employed by *Bunehs* and paid either in cash, in kind, or a combination (Safinejad, 1989).

Ethico-religious frameworks: Zoroastrianism and Islam

To complete our sketch of the pre-modern water paradigm, we should draw attention to the belief systems that have supported the traditional socio-technical irrigation system morally as well as legally, Zoroastrianism and Islam.

Zoroastrianism, the dominant religion in the pre-Islamic era, rests on three pillars: *Humata* (Good Thoughts), *Hûkhta* (Good Words) and *Hvarshta* (Good Deeds). By 'Good Thoughts', a Zoroastrian is able to concentrate his mind in divine contemplation of the Creator, and live in peace and harmony with his fellow man. By 'Good Words', he is obliged to observe honesty and integrity in all commercial transactions, to prevent hurting the feelings of others, and to engender feelings of love and charity. By 'Good Deeds', he is directed to relieve the poor, to irrigate and cultivate the soil, to provide food and fresh water in places where needed, and to devote the surplus of his wealth in charity to the well-being and prosperity of his fellow man.

Nature is central to the practice of Zoroastrianism and many important Zoroastrian annual festivals are in celebration of nature; new year on the first day of spring, the water festival in summer, the autumn festival at the end of the season, and the mid-winter fire festival (Jafarey, 2005). In the *Avesta*, the holy book of Zoroastrianism, there is strong emphasis on the protection of water and soil.

Like Zoroastrianism, from its very origins fourteen centuries ago, Islam offers a basis for ecological understanding and stewardship. According to the *Qur'an*, the universe and everything in it has been created by God and is considered a sign (*āyāt)* of God. Human beings, although at the top of creation, are only members of the community of nature. Humankind is just considered as a trustee for the planet: humans are entitled to live on the Earth and benefit from it but they are not entitled to pollute or destroy the environment. Any behaviour that can jeopardise the future of the natural resources is seen as an act against God and His creation (Abdel Haleem, 1989).

Nature has been created in order and balance, and with extraordinary aesthetic beauty, and all these aspects of nature, while enhancing humankind's life should be honoured, developed and protected accordingly. All patterns of human production and consumption should be based on this overall order and balance of nature. The rights of humankind are not absolute and unlimited: we should not simply consume and pollute nature as we wish, carelessly (Özdemir, 2003).

Water is a pivotal issue in Islam, not surprisingly since it is a religion that originated in a desert area and spread mainly to other arid or semi-arid territories. It is evident from numerous verses in the *Qur'an* that water is a major theme in Islamic cosmogony and iconography as well as a recurrent topic in liturgy and daily life (Gilli, 2004). One of the most famous verses pertaining to water is taken from the '*Sura* of the Prophets' and it states, 'We made from water every living thing'. This is not the only verse where the word *Ma'* (water) appears, since it occurs more than sixty times in the *Qur'an*.

In Islam, all water is sacred and sent as a gift from Allah. It is one of the three things that every Muslim is entitled to; grass (pasture for cattle), water and fire. Water should be freely available to all and any Muslim who withholds unneeded water sins against Allah. Mohammad attached great importance to the moderate use of water and forbade its excessive use even when performing ablutions, saying that to do so was 'detestable' (*makrūh*). He even prevented people from using too much water for ablutions when preparing to enter the Divine Presence for prayer.

There is a fundamental difference in the valuing of water between Islam and Christianity. Whereas Islamic doctrine ascribes holiness to all water, in Christianity only water that has been blessed in the name of Christ is sacred. Francesca de Châtel gives some striking examples of the undervaluation of water in Christianity. Saints of early Christianity boasted that water had never touched their feet except when they had to wade across a stream. St. Jerome denounced bathing as a pagan practice and affirmed that 'He who has bathed in Christ [i.e. has been baptised] does not need a second bath' (Châtel, 2005a: 56).

Islamic law, the *Shari`ah*, goes into great detail on the subject of water to ensure its fair and equitable distribution within the community. The word 'Shari`ah' itself is closely related to water. Originally it meant 'the place from which one descends to water'. Before the advent of Islam in Arabia, the *Shari`ah* was, in fact, a series of rules about water use. The term later evolved to include the body of laws and rules given by Allah. There are two fundamental precepts that guide the rights to water in the *Shari`ah*: *shafa*, the right of thirst, establishes the universal right for humans to satisfy their thirst and that of their animals; *shirb*, the right of irrigation, gives all users the right to water their crops.

It should be obvious by now that the technical, social and ethical aspects of the traditional system of land and water management were highly interconnected. The *Qanat* underground irrigation system was dependent on the social institution of the *Buneh* to operate properly, while Zoroastrianism and Islam can be considered as an adequate ethico-religious framework for this socio-technological arrangement. But around the middle of the twentieth century the 'Age of *Qanats*' came to an end.

3. INDUSTRIAL MODERNITY AND THE END OF THE AGE OF QANATS

The hydraulic mission – the replacement of Qanats by deep wells and large dams

From the late nineteenth century until the 1970s, Northern industrialised economies were dominated by the vision and politics of what has been termed the 'hydraulic mission' (Allan, 2002). This mission, involving hydraulic mega-projects like gigantic dams and large-scale irrigation systems, was inspired by the belief that nature, including water, can be controlled and should be subjected to the mastery of science and industry. This mission was implemented in liberal western economies, first and foremost in the United States (Worster, 1992; Reisner, 1986), but also in the centrally planned economies of the Soviet Union.

In the second half of the twentieth century, the hydraulic mission was introduced to the developing countries of the South, especially in India but also in Egypt and other countries of the MENA region. In Iran too, it was assumed that arid regions could be industrialised by making the necessary water resources available through building dams, pumping up groundwater and bringing in water from remote sources in order to 'make the desert bloom'. To pave the way for industrial modernity, the Iranian authorities tried to belittle all traditional irrigation and production systems. Most Iranian scholars and politicians exaggerated the technical deficiencies of the *Qanats* to justify their own programmes and to convince farmers to use pump extraction instead of *Qanats* (Khaneiki, 2007).

At first, modern devices such as pumps and drilling machines received no warm welcome, but after some pumped wells were drilled, farmers started to express their admiration for these new technologies. After all, while the construction of a *Qanat* would sometimes take tens of years, drilling a well took less than one month. If the farmers wanted to increase the discharge of a *Qanat* even a little bit, they had to extend the tunnel, which would take two or three years, whereas it was easy to increase the discharge of a pumped well by two times just through changing the diameter of the pump or adding some units or parts (Yazdi and Khaneiki, 2007).

Electric and diesel-pumped wells offer advantages over *Qanat* irrigation by allowing water to be brought to the surface on command, but over-pumping has caused water tables to fall, aquifers to be depleted and *Qanats* to be abandoned at an accelerating pace. The role of *Qanats* in securing all the functions of water in Iran has decreased from 70 per cent prior to 1950, to 50 per cent around 1950 and to 10 per cent in the year 2000 (Haeri, 2006).[5]

The substitution of the Buneh by a system of smallholding

The use of mechanically-pumped wells was heavily encouraged as a result of the Land Reform Act of 1962, which broke up the large estates and redistributed land to the peasants. The general pattern of land ownership in Iran prior to the land reform was a combination of large-scale feudal landownership with small-scale absentee and peasant proprietorship (Lahsaeizadeh, 1993). Because of the importance of artificial irrigation to Iranian agriculture, sharecropping (*muzara-eh*) was dominant among the different types of relation between the peasant and landowner. This traditional system of land ownership and tenure, and the socio-economic organisation of villages (*Buneh*), were well adapted to the optimal use of the *Qanat* system. The land holdings given to the peasants following the Land Reform were too small to maintain the *Qanats*, while many landowners and farmers now prefer pumped wells and allow their *Qanats* to languish. In effect, the traditional sense of water resources management for the benefit of the community seems to be giving way to an 'every man for himself' mentality. In addition to the mostly privately owned and constructed wells, the public sector is engaged in the construction of many large-scale dams.

The emergence of a mechanistic worldview

The new water resource management regime of deep wells and large dams is more in tune with a mechanistic worldview than with the ethico-religious frameworks of the past. Critics of the mechanistic worldview fear that if man sets himself up as the measure and master of all things, nature will appear solely as 'material' that he can control and command as he pleases. Nature, including water, ceases to be an independent source of value and turns into a mere resource to be disposed of at will instead. To quote Donald Worster's 1992 book *Rivers of Empire* on the advent of the hydraulic society in the American West:

> The most fundamental characteristic of the latest irrigation mode is its behaviour towards nature and the underlying attitudes on which it is based. Water in the capitalist state has no intrinsic value, no integrity that must be respected … It has now become a commodity that is bought and sold and used to make other commodities … It is in other words, purely and abstractly a commercial instrument. All mystery disappears from its depths, all gods depart, all contemplation of its flows ceases … Where nature seemingly puts limits on human wealth, engineering presumes to bring unlimited plenty. Even in the desert, where men and women confront scarcity in its oldest form (…) every form of growth is considered possible. (Worster, 1992: 52)

Modern water technologies have deeply affected the way people perceive, value and use water. In her paper on the conversion of rainwater into tap water, Nicole Stuart argues that industrial technologies dissociate people from the natural environment upon which they depend. 'Urban water infrastructure allows people to "take water for granted" … The urban water infrastructure provides an "illusion of abundance" – enabling twenty-four hour access to clean and potable water, seven days a week' (Stuart, 2007: 419).

Based on four years of field research in 11 countries of the MENA region, Francesca de Châtel (2005b) came to a similar conclusion with respect to public awareness of water scarcity. The sheer size of dam reservoirs and the huge amount of water that is transported through pipelines leads the general public to believe that water supplies are endless and conceal the reality of water scarcity. Moreover, through the development of modern water distribution systems, the link that used to exist between the individual user and his water is severed. As soon as water starts flowing from a tap, it is taken for granted. People forget that a fluctuating river or an erratic weather system lies at its origins. 'By making its source invisible, water's existence is divorced from the elements and the seasons, and it becomes paradoxically omnipresent. The user can comfortably assume that it flows from an endless supply' (Châtel, 2005a).

4. REFLEXIVE MODERNITY

The ideas underpinning industrial modernity were challenged during the 1960s and 1970s, when some of its disastrous effects – 'the hydraulic society's worsening headaches' (Worster, 1992: 324) – such as salinity, sedimentation, pesticide contamination, diminishing hopes of replenishment and the dangers of aging, collapsing dams, begun to appear, not only in the U.S. and other Northern countries but also in Southern countries like Iran, where, over the past four decades, farmers and others close to the land have watched water tables drop as one well after another dried up, and formerly fertile lands were inevitably taken out of production (Foltz, 2002).

As a response to these challenges a new paradigm has emerged, the paradigm of 'reflexive modernity'. As already mentioned in the introduction, reflexive modernity does not imply a break with modernity, but refers to a radicalisation within modernity – a 'modernisation of modernity'. Radicalised or reflexive modernisation is a process whereby modernisation has become directed at itself, at the destructive and continually expanding side-effects and risks that are systematically produced by industrial society. While nature in 'first' modern societies is conceived of as a neutral resource, which can and must be made available without limitation, nature in 'second' modern societies 'is no longer solely perceived as an outside that can be adapted to one's purposes, but increasingly as part and parcel of society' (Beck et al., 2003: 7). Beck argues for 'ecological enlightenment', which requires a reorientation from a focus on economic growth to one of sustainable development (Beck, 1995).

According to Tony Allan (2006), reflexive modernity in the area of water management can be shown to have three phases. In the first phase, from the 1960s until the 1980s, changes in water policy were inspired by the growing awareness of the *environmental* costs of the hydraulic mission. In the second phase, from the early 1990s onward, the idea that water is an *economic* resource gained currency, paving the way for the concept of the water market. In the third phase, which emerged at the turn of the century, the notion that water management is a *political* process seized the North. This notion is central to the concept of Integrated Water Resource Management (IWRM). IWRM is an intensely political process which includes stakeholder consultation and participation to enable the mediation of conflicting interests of water users and water management agencies.

Allan believes that, by and large, the semi-arid North can be shown to have passed through all three stages of water management and water policy. In the South, by contrast, the professional community generally, and all water users and politicians, have resisted the adoption of the paradigm of reflexive modernity. Especially in the MENA region, the hydraulic mission of industrial modernity is still alive and flourishing. 'The big players, Egypt, Turkey and Iran, are all engaged in major hydraulic projects' (Allan, 2002: 145).

Allan's sketch of the course of reflexive modernity in water policy in the North is not only meant as a purely empirical description, but also as a normative prescription for water policy reform in the South. This is, however, very problematic on two accounts. In the first place, it seems to place too much faith in a unilinear model of institutional evolution. According to Frances Cleaver (2002), such a model fails to recognise that decision making and cooperative action are deeply embedded in the web of local livelihood networks and practices. To understand the complex and dynamic nature of institutional change we should see it as a process of 'bricolage', i.e., a process operating by trial and error and using a diverse range of social and cultural resources.

In the second place, Allan fails to recognise that the course that second modernity has taken within a European constellation will differ considerably from its course within non-European constellations, where the dynamic of reflexive modernisation displays its effects not on first modern societies but rather on the distorted constellations of post-colonialism. '*Different non-European routes to and through second modernity* still have to be described, discovered, compared and analysed' (Beck et al., 2003: 7). The next section will give a rough sketch of a possible trajectory to reflexive water management in Iran and other countries of the MENA region.

5. TRANSITION TO REFLEXIVE MODERNITY IN IRAN

Restoration and integration of Qanats

At the Fourth World Water Forum of 2006 in Mexico there was general agreement that nations should consider both small-scale decentralised solutions and large-scale approaches involving dams and reservoirs to meet their needs at the lowest possible social and environmental costs. Furthermore, the forum remarked that, regrettably, local knowledge and adaptive technology development have been neglected historically, and recognised that knowledge coming from several sources could be complementary and might reinforce each other in solving water issues locally. In the context of Iran's transition to reflexive water management the forum's recommendation to try for 'a proper mix of science, technology and local knowledge' would imply a rehabilitation of the traditional *Qanat* underground irrigation system and its integration with modern water supply systems.

The rehabilitation of the *Qanat* system is important because this system represents one of the most ecologically balanced water recovery methods available for arid and semi-arid regions. *Qanats* tap the groundwater potential only up to, and never beyond the limits of natural replenishment and, as a consequence, do not upset the hydrological and ecological equilibrium of the region. As the *Qanats* are often dug into hard subsoil, there is little seepage, no rising of the water table, no waterlogging, no evaporation during transit – and hence no salination in the area surrounding the conduits. Moreover, *Qanats* rely entirely on passive tapping of the water table by gravity only, whereas the extractive pumps consume an enormous amount of fuel per year.[6]

However, the rehabilitation of the *Qanat* irrigation system can only succeed with the help of modern technology. Modern mining technologies can be used to enhance the water efficiency of the *Qanat* system, whereas water productivity can be improved by combining *Qanats* and modern irrigations systems.[7] Such a revitalisation of the *Qanat* system by modern technological means can result in a substantial decline of our dependency on deep wells.

What is required in addition to the restoration of the *Qanat* system is its integration in a modern environment. The rapidly increasing demand for water due to population growth and agricultural expansion in Iran cannot be accommodated by *Qanats* only. Therefore, what is called for is a complementary system of all three methods of water provision. Among other things, this implies that existing *Qanat* systems should no longer be ignored during the building of large dams and the excavation of deep wells. Islamic water law ensures that new irrigation systems or wells are not constructed too close to an existing one. However, with the emergence of the pumped tube well, the traditional *harim*-area (usually between 100 and 300 metres) does not suffice any longer and should be enlarged considerably.

Fortunately, there is a revival of interest in several countries where ancient underground irrigation systems have been declared as national heritage. The Government of Iran is lately giving much attention to the *Qanat* system. The first international Qanat Research Conference was held in Yazd in 2000. As a result of the recommendations of this conference, the Government of Iran has established the International Qanat Research Centre in Yazd in collaboration with Afghanistan and Pakistan, and with support from UNESCO.[8] Another example is China, where the Song Yudong group, in close collaboration with Xinjiang local authorities, has come up with several practical suggestions to revitalise existing *Karez* systems, including an overall plan for protection and improvement of the existing system in Turpan Prefecture in China. Recently international organisations such as UNESCO, and the United Nations University (UNU) have also shown interest in promoting studies on the *Qanat* system through the International Hydrological Program and the Traditional Technology in Drylands Program that supports young researchers from countries with a long tradition and heritage of *Qanat* systems such as Syria, Oman, Tunisia and Yemen to undertake systematic studies (Kobori, 2005).

New participatory arrangements

Because the *Qanat* system as a socio-technical system can only operate within a suitable social context, its restoration is impossible without renewal of the traditional social infrastructure. The traditional organisation of villages (*Buneh*) was well adapted to the optimal use of the *Qanat* system. A major disadvantage of the *Buneh*, however, was its hierarchical structure and the unequal division of labour and crops. The land reform of 1962 brought an end to this feudal situation, but at the same time it sounded the death-knell of the *Qanat* system.

What is needed in order to restore the *Qanat* system under present-day circumstances is some form of water resources management that encourages collective action with a participatory rather than a hierarchical character. Here, the concept of Multi-Stakeholder Platforms, that has become popular as an institutional framework for resolving complex resource management problems, could be helpful (Warner, 2007). The idea is that multiple stakeholders, who have different interests and needs with respect to water, should organise and arrange water use and conservation issues amongst them through some form of cooperation, including the building of capacity for collective learning and decision making. Today, such water user associations are emerging in many countries of the Muslim world.

Towards an Islamic land ethic?

To round off our sketch of a possible pathway to a more reflexive water management in Iran and other countries of the MENA region, we need to focus on the belief systems that could facilitate or hamper such a transition. As we have previously argued, with Francesca de Châtel (2005a; 2005b) and Nicole Stuart (2007), industrial water technologies tend to dissociate people from their natural environment. Restoration of the *Qanat* irrigation system could help to reconnect people with nature and to encourage greater ecological awareness and activism. To achieve this, however, more is needed than the purely technical restoration of the *Qanat* system and the creation of water-user associations. Presently, the general public in Iran tends to perceive this sustainable water supply system as outdated and backward.

Since religion still exerts a very big influence on Iranian society and because water plays a pivotal role within Islam, awareness campaigns based on religious principles could be very useful to counterbalance the mechanistic worldview underlying industrial modernity and the undervaluation of water due to the influence of modern water supply technologies. As Holmes Rolston has recently remarked, 'Christianity, together with other faiths that influence human conduct, needs again to become "a land ethic"' (Rolston, 2006: 312).

According to Muslim teaching, water is a gift from God that should be freely available to all. At present, this creed leads to gross underpricing of water, which in turn results in widespread wastage. What seems to be forgotten is that the *Qur'ran* also incites believers to use water sparingly. Mankind is not entitled to ruin, corrupt, pollute or destroy the environment. Any behaviour that can jeopardise the future of the natural resources, water included, is seen as an act against God and its creation. Preventing the corruption of natural resources or the pollution of water is not simply an ethical and civilised behaviour but it is also an act of worship. In fact, saving water is a religious duty.

In the last decade these Islamic principles have been widely implemented in the Muslim world, including Iran, through awareness campaigns. Mosques were used as platforms for these campaigns, and imams have been properly trained in drawing the attention of the believers on water scarcity during the Khutbah, the Friday sermon. Posters, leaflets, booklets and stickers using religious terminology and imagery have also been used to promote awareness of water issues (Gilli, 2004).

CONCLUSION

To highlight the problems and perspectives of water resources management in Iran and comparable arid and semi-arid countries in the MENA region, three subsequent paradigms have been identified, the traditional, the industrial and the reflexive paradigm Each of these paradigms consists in a specific technology-governance-people nexus: within every paradigm, technologies, social institutions and environmental mentalities are linked and are constantly shaping each other.

We have focused on the *Qanat* irrigation system as one of the oldest feats of human engineering, which was established about 3000 years ago and has been diffused throughout arid and semi-arid regions globally ever since. After a brief sketch of the nature and history of this ancient irrigation system, we have outlined its institutional context (*Buneh*) and the underlying ethico-religious belief system (Zoroastrianism and Islam). However, due to the land reform of 1962, with the introduction of the pumped tube well and the construction of large-scale dams, the 'Age of Qanats' came to an end: the *Buneh* system of sharecropping gave way to a system of smallholding, and a mechanistic worldview emerged in which society and nature became more and more disconnected.

Recently, with the growing danger of water scarcity and the manifestation of some negative effects of modern hydraulic technology, we witness the transition from the 'hydraulic mission' of industrial modernity to a more reflexive approach to water management. An important aspect of such a transition in Iran and other MENA countries is the rehabilitation of the traditional *Qanat* underground irrigation system and its integration with modern water supply systems. By enhancing the water efficiency and water productivity of *Qanats*, e.g. with the help of modern mining technologies and modern drip irrigation systems, such rehabilitation can lead to a significant decline of the dependency on deep wells. It can also help people to reconnect with nature and to encourage greater ecological awareness and activism.

At this moment, however, rehabilitation of the *Qanat* system is hampered by the general public's perception of this sustainable water supply system as outdated and backward. Since religion is still of great importance in Iran and because water plays a pivotal role within Islam, awareness campaigns based on religious principles could be very useful in overcoming this unfavourable image.

NOTES

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[1] Like other MENA countries, Iran can never be fully self-sufficient, but will remain dependent on importation of water-intensive staple food commodities. While in 1999 Iran was the ninth highest wheat importer and the third highest rice importer in the world, in the year 2001, due to a prolonged drought, Iran rose to the position of fifth-highest wheat importer in the world. (Alizadeh and Keshavarz, 2005: 97). To increase efficient water use domestic food production should be balanced with food importation.

[2] With an annual rainfall recharge reaching the aquifers of 46.6 billion cubic metres and an annual discharge from the groundwater of 49.7 billion cubic metres Iran has a negative groundwater balance of over 3 billion cubic metres (Moameni, 2000).

[3] The largest known *Qanat* is in the Iranian city of Gonabad; after nearly 2,700 years it still provides drinking and agricultural water to nearly 40,000 people. Its mother well is 360 metres deep and the channel is 45 km long (Kobori, 2007).

[4] The system has been variously named – *Qanat* in Iran; *Qanat Romani* in Syria and Jordan; *Karez* in Afghanistan, Pakistan and Turkmenistan; *Kahn* in Baluchistan; *Kanerjing* in China; *Falaz* in Oman and other parts of the Arabian Peninsula; *Foggera* in Algeria and other North African countries; *Khattara* in Morocco; and *Galleria* in Spain (Kobori, 2007).

[5] However, it is important to know that today the traditional *Qanat* systems continue to provide water for as much as one third of irrigated land (Foltz, 2002).

[6] In the Yazd area there are 4,340 wells with extractive pumps, which totally consume 205,854,880 litres of gas oil a year in order to obtain 926,350,000 cubic metres water. But in the same area there are 2,948 *Qanats*, which withdraw 329,870,000 cubic metres water a year without any fuel (Khaneiki, 2007: 81).

[7] In Syria Wessels and Hoogeveen (2006) have seen that combining ancient *Qanats* and modern drip irrigation systems for fruit trees might prolong the life of some *Qanats* and encourage the younger generation to commit to their upkeep. Another option they mention is to encourage eco-tourism based around *Qanats* to provide alternative income for the farmers.

[8] http://www.qanat.info/en/sitemap.php (accessed March 10, 2008).

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