Environ Dev Sustain (2013) 15:1605–1621
DOI 10.1007/s10668-013-9452-2

CASE STUDY

Water management from tradition to second modernity: an analysis of the water crisis in Iran

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Received: 6 August 2012 / Accepted: 19 March 2013 / Published online: 29 March 2013

Abstract This article reflects on the fundamentals of first and second modernity and its usefulness and practicability for problem formulation and solving in the context of water management practices in Iran. It is argued that the current water crisis in Iran resulted from modernization based on first modernity paradigms, and second modernity concepts are used to present a framework for new water management approaches. Based on the concept of sub-political arrangements, we suggest that water management issues can be treated best in process-based ways under a reflexive modernity point of view.

Keywords Reflexive modernity · Modernity · Water crisis · Water management · Sub-political arrangements · Process-based · Iran

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1 Introduction

Modernity can be seen as a mode of social life or organization that began around the seventieth century in Europe before spreading worldwide (Giddens 1990). According to Brouma (2003), the "main principles of (First) Modernity (FM) were practically incorporated in the formation and institutionalization of nation-states as the dominant state structure, the implementation and prevalence of capitalism in the economic arena and finally the introduction and establishment of liberal democracy in the political sphere". The three principles of FM, as laid out by Brouma (2003), are based on a scientifically defined concept of rationality that emphasizes instrumental control. Rational progress is conceived of as a process of demystification that can continue without limitations. Thus, it is a general model of evolutionary social development (Coleman 1968) in which the core societal goal is economic growth. Its dominant individual goal is achievement through income and consumption rather than through moral standing. An important characteristic is the devaluation of tradition through universalization of the norms of action, generalization of values and individual-based patterns of socialization. The value of traditions is heavily debated; for example, for Jenkins (2000), tradition is at best a way of presenting the past as an increasingly scarce non-renewable resource and, at worst, an impediment to progress.

In the 1990s, Beck and Giddens critiqued, enhanced, extended and combined many of the existing disciplinary perspectives and theoretical approaches to risk, including those developed within sociology, political science, anthropology, geography and psychology, to present the concept of "Second Modernity" (SM) (Ekberg 2007) as a new approach to the changing nature of modernity. The main concept of SM is that the processes of globalization and individualization are occurring simultaneously and are driving the emergence of an increasingly self-critical, "reflexive", "risk society" (Beck 1992, 1999; Beck and Beck-Gernsheim 2002). For Giddens (1999), a risk society is "a society increasingly preoccupied with the future (and also with safety), which generates the notion of risk". Beck (1992) defines it as a systematic way of dealing with hazards and insecurities caused by modernization itself. SM demonstrates an increasing awareness that it is impossible to control contemporary risk (Benn et al. 2008). This increased critique of modern industrial practices is said to have resulted in a state of reflexive (i.e. subject to reappraisal and re-evaluation) modernization, illustrated by concepts such as sustainability and the precautionary principle that focus on preventive measures to decrease the levels of risk. Thus, SM is oriented toward reconstruction (Lee 2006) and an opportunity for renewal (Ekberg 2007). Hence, classical modernity, of which industrial societies form part, is being replaced by reflexive modernity (Beck 1992), in which all aspects of contemporary life are sensitive to re-appraisal and re-evaluation as a result of constantly emerging new knowledge and information and the changing values and priorities that result from them.

It is argued (see for example Healy 1997) that while modernity has not ended, to continue, it must fundamentally change. In this regard, SM addresses the production of a new version of capitalism, society, nature, subjectivity and state (Beck et al. 2003). To overcome the limitations of modernity, it has the potential to develop new solutions to new problems, design new social institutions to monitor the social impact of emerging technologies and establish new regulatory systems to manage the risks associated with new technologies (Ekberg 2007). Thus, having been applied to social change across the world, SM attempts to bring to fruition a sustainable economic and political environment under the aegis of modernity (Lee 2006).

This article reflects on the fundamentals of FM and SM and its usefulness and practicability for problem formulation and solving in the context of water management practices

in Iran. It is argued that the current water crisis in Iran resulted from modernization based on FM paradigms. A wide range of solutions have been developed and implemented to manage this crisis, inter alia, participatory management, collaborative decision-making and decentralized management. To date, however, there has been no conceptual framework to guide these often conflicting objectives. The water crisis has demonstrated that conventional development strategies are fundamentally limited in their ability to promote sustainable management (Karami 1993). Moreover, failure to incorporate these problems into a conceptual development framework has led to the formulation of passive and haphazard development policies in Iran (Rezaei-Moghaddam et al. 2005). To overcome these shortcomings, SM is used as the conceptual framework to investigate the Iranian crisis in the water domain, focussing on the interactions between the water system, autonomous behaviours, water policy and cultural change. We review the existing literature on reflexive modernity and water management with the goal of elaborating a novel framework for water management in Iran.

The paper is organized as follows. Section 2 compares the differences between FM and SM based on a normative perspective. Afterwards, in Sect. 3, we provide a history of water management practices in Iran based on the discussion in Sect. 2. In Sect. 4, we investigate if and how SM could help to overcome the part of the water crisis. Finally, Sect. 5 concludes.

2 First modernity and second modernity: a comparison

This section provides a review of the two theories highlighting the main differences. A comparison of the key features is summarized in Table 1.

While the subsequent discussion is far from complete, the idealized characterizations are useful for both clarifying opposing positions and facilitating comparison within the case study.

2.1 Ideology and goals

The probably most important difference between FM and SM is their philosophical perception of the world. FM derives from an era of optimism which assumed that the world is a safe, secure, certain and a predictable place (Ekberg 2007). This led to positivism (Tacconi 1998), and positivism itself arises from enlightenment (Brouma 2003). In contrast, the SM approach does not rely on optimism, but is characterized by dislocation, disintegration and disorientation associated with the vicissitudes, insecurity, uncertainty and ambivalence of de-traditionalization. SM theory, which is also called ecological enlightenment, comes from the Frankfurt school and has its origins in critical theory (Ekberg 2007; Rutherford 2000; Cohen 1997). It requires a reorientation from focusing on economic growth to focusing on sustainable development (Beck 1995a). Although both FM and SM theories emphasize on progressiveness (Ekberg 2007), SM calls for greater intensification of reason. Additionally, a deepening of democracy is essential for progress to be made (Beck 1995a). In contrast, democracy has not received much attention, if any, under FM.

2.2 Role of the state

In FM, the bureaucratic state controlled civil society and is the central actor in setting policies for society. The policymaking process is based on a rational model which assumes

Table 1 Comparison of key features between first and second modernity theories

Key features	First modernity	Second modernity
Ideology and goals	Enlightenment–positivism Optimism and consensus Linear progress and economic growth Class politics	Ecological enlightenment–critical theory Uncertainty and ambivalence Multiple progress and sustainability Ecological politics
Role of state	Welfare state Government as central actor is steering Classical, technocratic and rational decision-making Centralized	Negotiation state Network of interdependent actors: all actors are steering "Sub-political" decision-making; struggle, dialogue, power play Decentralized
Role of science technology and expertise	Absolute facts and reality; absolute truth Certainty rule for science Scientist and specialist Reductionist-closed circular of scientist lab Transfer of technology—passive learner Social change	Multiple realities, approximate truth The precautionary rule for science All stakeholders Negotiation–multiplication of claims to knowledge Sub-political area Social learning–active learner social innovations
Dealing with risk	Measures risk as an objective fact and statistical value Scientific risks	Describing risk as a subjective or intersubjective experience Political risks
View on individuals	Trusting, unquestioning, passive individual Respected experts, acting on their advice. Professional–client interaction Increasing acceptance, consensus	Untrusting, questioning, active Doubt about experts. Be a expertise Knowledgeable ones "self-responsible"
View on nature	Instrumental; neutral and infinite provider of nature Outsider; separate Resource sufficiency To fulfil all basic human needs, now and in the future The "agriculturist" point of view	The value of nature is found in intimate, mutually benign processes between humans and nature Part and parcel of society–systemic functional integrity The mutual flourishing of the human and non-human world, now and in future The "ecologist's" point of view

that policymaking proceeds in stages (from problem statement, to planning, to implementation). As the state makes rational decisions, it considers all problems and alternatives (Termeer 2009). Moreover, the view of the "big push" by the state is a major feature of this era (Mycoo 2005), where the state is called the provident (Webster 1999) or welfare state. Welfarism represents a desire to link the expertise of networks to state political projects with the aim of achieving social and economic progress. Here, the state facilitates economic growth by guaranteeing both freedom of the individual and freedom of the enterprise. This freedom comes through a set of rights and obligations (Rose 1993), in which social and economic progress is achieved through direct interventions in the economy and the labour market (Rose and Miller 1992). Consequently, the state has both a capitalistic and a paternalistic role. Typically, rational decisions in this paradigm stem from "classical" decision theory and are "goal-oriented" (Pahl-Wostl 2002). As a result, in FM, decisions have been taken based on objectivity; the greater the objectivity, the greater

the consensus, and as a result of extended consensus, they provide universal solutions or "technocratic decisions" (Ekberg 2007).

Regarding the transition to SM, on the one hand, Beck (1996) believes that in FM, a system emerging from a welfare state will not be efficient enough to tackle the existing risk. On the other hand, in SM, citizens have stopped trusting the state and want less state surveillance, as they have lost confidence in the institutions. As a result, activist groups without any class-based background emerged (Howes 2002). Thus, in SM, the role of the state either changes or shifts to other agents. SM amends the traditional central role of the state in the decision-making process, and it includes experts, counter-experts and non-experts in new forms and forums of debate. This climate of debate has led into the rise of a "sub political" decision-making arrangement (Beck 1997), and its consequences are ad hoc solutions (Beck et al. 2003). The term "sub politics" refers to the temporary, multiple stakeholders, decentralized and flexible arrangements, and networks, which are increasingly taking over decision-making and are sources of legitimization and action in the society (Benn et al. 2009). Sub-political arrangements can provide more horizontal interactions and can be regarded as a way of decreasing the perceived gap between government and society, of enriching solutions, enabling social learning, dealing with uncertainties and increasing the chances of bringing policies to fruition (Koppenjan and Klijn 2004). As a result, the authoritarian decision and action state is giving way to the negotiation state (Webster 1999).

2.3 Role of science technology and expertise

The disagreement between FM and SM theories become evident when their conflicting ideas on science technology and expertise are analysed. The roots of FM lie in the revolutionary thinking based on reason and science of the enlightenment period (Brouma 2003) and in the particular brand of rationality that underpins contemporary scientific enquiry (Cohen 1997). Here, decisions are made by scientists without public consultation and without the explicit consent of the citizens (Beck 1992); thus, both science and scientists are accorded high positions in this ideology (Pellizzoni 1999). Other parties such as lay people are seen as passive learners, being coercively convinced through scientific demonstration (Luks 1999). In this paradigm, innovation can be perceived as the source of social change and modernization as an example of social change. It was associated with economy and technology and focused particularly on technical applications enabling dynamic economic growth (Gabriela 2012).

Although science in SM theory has a nested chain of contradictions, it has lost the image which has been influential over humanity's future prospects. On the one hand, the public is starting depend upon external knowledge; on the other hand, science is simultaneously and increasingly losing its monopoly on rationality and becoming "demystified" (Jensen and Blok 2008). According to Beck (1992), science is no longer a source of solutions, but a cause of many problems, and people no longer trust it. In other words, just as scientific world views have encouraged citizens to be sceptical about claims to authority, so people have started distrusting scientific expertise itself (Howes 2002). In this context, Luks (1999) states that there is an increasing tendency for an increasingly individualized lay public to reflexively question the assumptions of science and the expert systems themselves. As a consequence, lay people are no longer assumed to be passive actors, for example, experts are not allowed to decide or answer life's ethical and ontological questions in isolation, and the traditional divisions between experts and lay people are no longer applicable (Beck 1999). In this paradigm, innovation no more only is seen as a tool and

resource of economic productivity and competitiveness, but also as a potential tool which can be used to reach social goals and social cohesion in society or social innovation. Thus, concepts of reflexive modernization offer an interpretative framework for social innovations (Gabriela 2012).

2.4 Dealing with risk

In FM, risks are random products of external nature (Ekberg 2007) and perceived as a probability in individual activities and social forces (Goldblatt 1996). However, in SM, risks are unanticipated and unintended consequences of advances in our technical power to understand and manipulate the inner complexities of nature (Ekberg 2007). While the former looks at risk through a realistic lens or through technical measures (Giddens 1998) and neglects the social construction of it, the later has a mixture of realist and constructivist views (Ekberg 2007; Lupton 1999a, b). The focal concern in FM risk research is to identify risks, map their causal factors, build predictive risk models constructed on people's responses and relations to various types of risk, and indeed to propose ways of limiting the effects of risks (Lupton 1999a, b). In this setting, risks can be identified, measured, classified and predicted by following the rigorous, reliable and reproducible methods and calibrated techniques of the quantitative sciences (Ekberg 2007; De Marchi and Ravetz 1999). In contrast, traditional responses to risk are no longer appropriate in SM. Moreover, state and scientific experts cannot sufficiently manage risk (Giddens 1998), which is increasingly seen as required skill in risk management (De Marchi and Ravetz 1999), and scientific calculations are being challenged more and more by political groups and activists (Beck 1995b). In first modernity, experts are assumed to be the main reference point for identifying and calculating risks, and ordinary people are supposed to trust expert advices on risk prevention and dealing with risks (Lupton 2006; Beck 1992). Thus, science adopts a rationalistic approach which assumes that expert scientific measurements and calculations are the most appropriate standpoint from which to proceed (Lupton 1999b).

Additionally, another important aspect of dealing with risk is the responsibility for risk management. By placing responsibility for risk management in the hands of institutions, the industrial society is creating a system of rules to manage the impact of risks (Benn et al. 2008). Responses to risks in FM are based on status, wealth and authority. Beck (1992) stated that institutions become less important than the mechanisms used to cope with and mitigate risks; risk decisions have been opened up to a wider array of participants, outside of the traditional experts and regulators, to external stakeholders, individual citizens and organizations, associations and movements. Summarizing, there is a different attitude towards risk, a different ontology and aetiology of risk, and a heightened sensitivity to the social and political consequences of a risk event in SM (Ekberg 2007).

2.5 View of the individual

The development of the industrial society is based on the misconception that citizens react passively and are naïve, deferential and obedient toward authorized expert attempts to control individuals' interactions (Hanlon et al. 2006). Indeed, to complete this vision, government programmes have usually a strong bias against the self-responsible actor model. These government programmes also increasingly address people through the significant lack of cultural and economic resources (Powell et al. 2007). Conversely, SM holds that local community members can challenge expert opinions, engage in the decision-making process and construct their own expertise (Benn et al. 2008). Advocates of

SM (Giddens 1998; Lee 2006) claim that each individual is able/allowed to anticipate and address risk. Moreover, this is best achieved by collectively sharing the responsibilities which may lead to individualization (Giddens 1998).

2.6 View of nature

FM has a particular concept of nature, namely the exploitation of nature. "It (nature) was simultaneously central to society and marginalized and appears as the 'outside' of society and finally nature is conceived of as a neutral resource, which can and must be made available without limitation" (Beck et al. 2003). In other words, it was characterized as anthropocentric (Beck 1999). This anthropocentricity has led to nature being perceived as a neutral and infinite provider; there is an inherently instrumental view that nature can be controlled by humans through science (Beck et al. 2003). As a result, many aspects of nature have been affected by purely scientific interests or by applied corporate science which aims to maximize profits (Giddens 1998). Therefore, according to FM, through the processes of industrialization and rationalization, one can learn not only how to control the natural environment, but how to protect oneself from its ravages (Giddens 1990). This world view is based on the conviction that a man can set himself up as a measure and master of all things, while nature is just seen as a "material" that is controlled and used for man's own ends. Nature, particularly water, ceases to be an independent source of value and turns into a mere resource to be disposed of at human will. In this world view, water is seen as a commodity that can be bought, sold and used for making other commodities. Having no intrinsic value, it can thus be manipulated in every way (Worster 1986). In this context, nature is primarily conceived of as a means of production, a good for consumption and a precondition for human health (Van Koppen 2000). Whenever nature is considered as a resource (Van Koppen 2000), it has three traits: (1) it is an instrumental value through which other value can be realized; (2) it is a supplier of material needs such as food, health, shelter, energy and other raw materials, and (3) it is defined according to the natural sciences. As a result, resource sufficiency is given high attention in FM (Thompson 1997). Resource sufficiency implies an instrumental relation to nature, with a focus on the predictability of resource use, food production and food distribution.

In SM, however, a new concept of nature seems to be developing. In this era of global ecological crisis, awareness of the limitation of our resources has been emerging. Nature is no longer solely perceived as an outsider that can be adapted to our own purposes, but as an increasing part and parcel of society (Beck et al. 2003). This began with the Giddens' concept "the end of nature" which means the point at which we stop worrying about what nature can do to us and begin to worry more about what we have done to nature (Giddens 1998). Accordingly, SM views nature as having functional integrity, namely as having a complex system of production practices, social values, and ecological relations (Thompson 1997). Nature can be looked at through a FM and a SM lens to provide two distinct concepts of man's relationship with nature. According to Alroe and Kristensen (2000), FM shows man separated from nature; SM shows man as an integral part of nature. The first can be called the "agriculturist's viewpoint" which values nature as a controlled, well-ordered and useful item to man. The second or "ecologist's viewpoint" considers the intimate, mutually benign processes occurring between man and nature.

3 Case study: water management in Iran

The history of water management in Iran can be usefully divided into three major periods, each period with distinct characteristics: the traditional, the modern and the crisis period.

3.1 Changes in paradigms: from tradition to modernity

Most of the area in Iran is *semi-arid*. The inhabitants of this plateau managed their water resources over thousands of years in a way which one may call "sustainable" (Labbaf Khaneiki 2007), that is, by developing technologies and practices which enabled them to survive and prosper under risk (Foltz 2002). In more detail, this includes the development of water mills, underground reservoirs, ice ditches, *Qantas* (chain wells and dikes), etc., in order to nurture and enhance the crucial resources (Farhangi 2007). Furthermore, they put in place ethical, social and cultural systems that worked in the same practical direction (Balali et al. 2009). Ancient Iran had two principal devices for water management: accumulated technical knowledge and a social–ethical–cultural system. Together, these devices recognized both the ecological realities of the plateau's desert climate and the social imperative of conserving and distributing water in a way that ensured its availability to all. Among the water technologies, the Qantas was key. It is a method of tapping groundwater without the use of lifting devices. By sinking a line of wells and then linking them with a gently sloping tunnel, the groundwater is brought from the higher ground until, after sometimes tens of kilometres, it reaches the surface to create what is, in effect, an artificial oasis (Lambton 1953). The system was not centrally planned; it grew incrementally and the fact that it went on growing and functioning for thousands of years could be seen as a proof that the groundwater it tapped was not being depleted but recharging as quickly as it was used.

At the state level, the ancient water authority took responsibility for adjudicating on water ownership, recording water shares, and calculating how much tax farmers had to pay for these shares. Water management did not ended here; the "dividing of the waters" (according to land ownership, irrigation rights, time shares and so on) had to be matched with likely changes in the volume of water over the year, and accurate and acceptable judgements on that sort of matching could only be achieved at the local level—by farmers, landlords (and/or their representatives/agents), Qantas diggers, blacksmiths, carpenters and so on—whose diverse contributions were vital to the sustainable functioning of this complex socio-technical system. Key to this grassroots element within the system of water governance was an institution known as the *Buneh*.

The *Buneh* was a multi-family collective: a farming cooperative, whose main function was to reconcile the efficient exploitation of productive land with the careful use of the available water (that availability itself being, in large measure, a function of the socio-technical skills inherent in the Buneh). All the Buneh's members, being peasants, were of the same social status, but there was a division of labour between them. Each Buneh, typically, had six members: the Buneh head (or irrigator), two assistants and three sharecroppers (Rezaei-Moghaddam et al. 2005). Buneh, however, were not autonomous; each was tied into a wider network that comprised the landlord (or his representative/agent), other Buneh within the village and a number of crucial specialists: the Qantas diggers (muqanui), blacksmiths, carpenters and village-level service providers such as barbers and bath keepers. This sort of network, with all its diversity and mutuality, constituted the production system. Salmanzadeh and Jones (1981), call this an "agrarian structure", shaped over many centuries by a complex set of interrelated physical and

cultural factors and replicated again and again across the Iranian landscape (Table 2 column two summarizes the water management aspects in this era). All this came to an abrupt end with the 1962 Land Reform Act, an intervention that was derived directly from a modern theoretical framework

3.2 Iran's modern water management paradigm

In the aftermath of World War II, a secular government, dependent on (but peripheral to) world capitalism, came to power in Iran. This was the background for the 1960 "White Revolution", an American-inspired transition to the sort of "free world" stance. Progress—by way of industrialization and urbanization—was the main revolutionary goal, but the agricultural and water sectors too were dramatically altered. These dramatic changes, however, were not anticipated, agriculture and the countryside being viewed as a backward part of the economy and one that had no real connection with the forward-looking industrialized and urbanized state that was about to be put in place (Asaesh 1994). Water management in particular would have to be transformed, and it was believed that new hydrological technologies, borrowed from the West, would be sufficient to meet the country's increasing water demand. It was assumed that arid regions could be industrialized by making the necessary water resources available by building dams, pumping out groundwater and constructing canals to bring water from remote sources to "make the desert bloom" (Allan 2005). This sort of approach in terms of the technical management of

Table 2 Components of pre-, first- and second modernity paradigms

Components of paradigm	Pre modern	First modernity	Second modernity
Rationality	Ecology-driven	Modernization	Post-modern
Goal	Survival	Progress and productivism	Precaution, equity, quality and environmentalism, post-productivism
Role of state	Indirect and incentive	Big lord and welfare state	Leader ship and facilitator
Water	Insider, public goods	Outsider, private good	Insider, common good
Value	Religious aspects	Western ideology	Ethical aspects
Supply	Non-equilibrium	Equilibrium	Non-equilibrium
Crisis	Low	High	High
Risk	High, uncontrolled and metaphysical,	High, predictable and controllable, big infrastructure	High, uncontrolled, decentralized infrastructure
Technology	Primary	Science-driven, modern	Integral design
Learning	Trial and error	T.O.T	Social learning
Professional	Local experts	Government and change agents, knower	Participate as a stakeholder
Farmers	Active user	Passive users	Active user in all process
Relation between state and people	Top–down and Naive networking	Welfare state-top–down. No effective relationship	Governance-networking. Multi-stakeholders negotiation and platform
Agriculture	Subsistence	Productivism	Multifunctional

water was variously labelled: the *prediction-and-control paradigm* (Pahl-Wostl et al. 2008) or *predictive management* (Neef 2009; Durant et al. 2004), which all can be subsumed within the more general concept of the *hydraulic mission paradigm* (Molle et al. 2008; Molle 2006). The assumption in the hydraulic mission paradigm is that nature can be controlled by scientific and technological means: the construction, for instance, of new and large-scale water systems comprising reservoirs, canals and hydroelectric stations. All this, moreover, would be planned and determined by state agencies, using state funding. The emphasis was on technical solutions to narrowly defined environmental problems, with regulatory authorities implementing those solutions on the basis of expert advice (Abdullaev et al. 2009).

Though the agricultural sector was marginalized during that era, it did not escape the sort of purposeful planning that characterized the White Revolution. The main impetus for the transition to modernity came in 1960, with the land reforms that broke up the large estates and redistributed the land to the peasants. This clearly weakened the place of the village in the hierarchy, and combined with other planned interventions (extension services, subsidized inputs and improved communications), it drastically changed the agricultural system. More land was brought into cultivation (Rezvani 2005), fertilizer use was significantly increased (Deihimfard et al. 2007), and there was a marked diversification of crops (Faramarzi et al. 2009). The dominant agricultural policy at that time was the green revolution with its emphasis on the high pay-off input model (Forouzani and Karami 2010). Thus, Iran experienced a double setback, with an industrialized style of agriculture and modern agriculture's package of high-yield varieties, fertilizers, pesticides and heavy irrigation being lumped on top of the White Revolution's land reforms. Inevitably, water demand increased (Karimi 2009) way beyond what the Qantas system could provide. As a result, many deep wells were sunk (about 500,000 deep and shallow wells and the same number of manually excavated open wells), and water was pumped with scant concern about the environmental effects of what is now called competitive deepening (Beck et al. 2011). The green revolution, centralized, expert approach, in line with the then-current goal of modernization, opened the way to an industrial style of agriculture. This approach, Nelson et al. (2008); Brunner and Steelman (2005) have argued, was both positivist and reductionist in the sense that it provided the tools that enabled the conquest of nature for the improvement of human welfare and, in the process, separated society from nature. Within that approach, water management was seen as primarily an engineering problem, that is, one in which the efficient solution lay in technological fixes. The discourse of this new water management paradigm, moreover, did not end there.

Modernization continued after the Islamic Revolution, but in a different direction. Increasing solidarity with other Islamic and revolutionary nations (Tajik and Darvishi 2004), together with a marked antipathy toward capitalist West, led to more rapid population growth (Fozi 2004), to a brake on the previous regime's factory building and also to a questioning of the regime's efforts to industrialize the agricultural sector (Foltz 2002). Agriculture thus became a core focus for Iran's post-revolutionary policy-makers (Ghadiri Masoum and Najafi kani 2003), and there was a marked expansion of mono-cropping and incentive-based grain production through interventions, such as guaranteed purchase, subsidies, crop insurance and so on (Deihimfard et al. 2007). The result was a new, and distinctly Iranian, modern agriculture, with more and more land (even land with marginal agricultural potential) being brought into cultivation (see Table 2 column 3 which summarizes the water management aspects in this era). Between 1973 and 1998, almost 483,000 hectares went under the plough, and many deep boreholes were sunk to provide those hectares with pumped-water irrigation (Balali et al. 2009).

3.3 The crisis period due to the modernity paradigm

Over the past four decades, Iranian farmers and others close to the land have watched water tables drop, as one well after another has dried up and formerly fertile lands have been forced out of the productive use. With ecosystem services increasingly being undermined by the loss of ecosystem functions, there is broad consensus that Iran faces a serious and growing water crisis. In fact, for more than a decade now, Iran has been faced with a water crisis so severe that the government has been forced to accept foreign aid for only the second time since the 1979 revolution (the first time being in 1990 after the devastating earthquake in northern Iran). This crisis, exacerbated by severe droughts in 2008 and 2009, has resulted in much of Iran's land ceasing to be productive. In the same year, an estimated 3 million tons of wheat and barley were lost (12 million tons of wheat being the estimated amount of grain needed to feed the entire Iranian population for 1 year). Fifty villages in Kerman province (Foltz 2002) were evacuated due to the lack of water. Though Iran has always had cycles of drought, a major World Bank report (Balali et al. 2009) confirmed that this time, things are different. Iran faces not a periodic dry spell, but a severe water crisis, made even worse by recent high rates of population growth. It is estimated that climate change, which will halve the per capita availability of water by 2050, will be the proverbial straw that breaks the camel's back. The crisis will turn into a *super crisis*, with more and more land being taken out of production over the coming decades (Balali et al. 2009).

4 Perspectives from a reflexive modernity point of view

That Iran now seems unable to cope with such a historically familiar reality suggests that, in its abandonment of traditional practices for modern ones, something has been lost. What exactly this is, however, has been obscured by the blurring of the distinction between the traditional and the modern that has long been central to the theory and practice of development. In response to these challenges, a variety of new solutions have been presented not only in Iran, but across the world. However, in SM, it is argued that instead of simply reframing old problems in new ways, substantive changes in water management are needed to bring about a transformation of water management principles and practice (see for example Pahl-Wostl et al. 2011). In a bigger image, Beck (1998b) sees this challenge to the whole of society and believes that "the script of modernity has to be rewritten, redefined, and reinvented". It involves radical social change through the modernization of the foundations of modernity itself (Beck et al. 2003). How this actually can be achieved in practice is the question at hand which we want to reflect upon next.

In more detail, the main question we address here is how the principles of SM could provide a suitable framework to find effective solutions to the current water crisis in Iran, and we suggest a process-based approach which involves interactions on various levels. It seems clear from the discussion in Sect. 2 that a key element of a new water management practice based on SM ideas is that water cannot be isolated anymore from social systems and inter-generational equity issues (Divan and Rosencranz 2005). Water management in SM therefore focuses on the interconnections between social, cultural, religious and technical aspects of the production system. One focal point of a new water management regime from a process-based perspective could be the already mentioned sub-political arrangements, which can be considered as similar to the Buneh arrangements in former times. Sub-political arrangements are especially useful in order to include multiple

stakeholders and multiple perspectives within the decision-making process. According to Benn et al. (2008), one of the strongest points in favour of sub-politics is that the national government is the least involved in the decision-making. In the sub-political arrangements, accountants, academics, medias, lawyers, doctors, nurses, computer personnel and others perform as interpreters or mediators of risk. Subsequently, citizens are expected to be reflexive and interpretative in terms of their situations (Hanlon et al. 2006). This process led citizens themselves to become "small, private, alternative experts" (Beck 1992) and to see themselves as critical "citizens". According to SM, traditional citizens are on the decline and being replaced by informed, active and knowledgeable ones "self-responsible actors" (Powell et al. 2007). This new individual competence is called new technological citizenship by Beck. It has four characteristics according to Hanlon et al. (2006), including (1) the sources of support that were used in the past are threatened today; (2) people no longer trust science and expertise; (3) hierarchy and status between lay people and experts are expected to decline; and (4) people are more informed, confident and knowledgeable than in the past and strive to be self-learning and questioning. The sub-political arrangements therefore are valuable within the complex decision-making situation where conflicting interests arise, as it enables problem formulation from different perspectives. The aim and eventually the result is not an optimal solution but to clarify values and opinions of the relevant stakeholders and to work out the sources of disagreement to develop compromise solutions (sometimes also called "clumsy" solutions, see the work of Verweij and Thompson (2011) in the context of cultural theory). As indicated, in this regard, reflexive water management is process based and can simultaneously take a whole range of trade-offs into account that involve different stakeholders during the whole management process. The process-based approach, therefore, is intended to help in the development of "socially best" policies and interventions. For example, in Iran, the competitive deepening and unanticipated salinization that modernization has given rise to cause the collapse of ecosystem functions and therefore ecosystem services too. While water turned out not to be as controllable as it was thought it would be and caused water shortages in nearly all parts of Iran in a reflexive water management approach, emphasis would be placed on ecological modernization and the focus would be on multifunctional agriculture rather than productivism, for example, by developing alternative sources for income (such as tourism or the development of small-scale industries) in arid regions (particularly in the central and western parts of Iran) where ground-water-based irrigation is not sustainable in the long run anymore; for other parts of the country, incentives to change cultivation patterns or to produce more tolerant crops could be initiated, more specifically cultivation of rice, one of the most water consumers of all crops could be limited, and raising barley instead which would make more ecological sense (see Foltz 2002). Also, market-based products (such as insurance) or water conservation techniques could be implemented dependent on the feasibility for given regions. There could be many other possibilities too and as such sub-political arrangements take the concept of stakeholder input beyond simply broadening democratic participation to the new processes, which includes continuous open dialogues and engagement on various levels. It should be noted that this also includes the assessment and incorporation of intangibles (i.e. non-quantifiable variables) within the decision-making process. Figure 1 below shows a possible separation of different risk bearers which could be part within sub-political arrangements on different levels. Furthermore, not only single risk (for example drought events) and its tangible and intangible dimensions relevant for each risk bearer have to be considered but also the other possible risks the specific stakeholder has to keep in mind within the decision-making process have to be taken account of too.

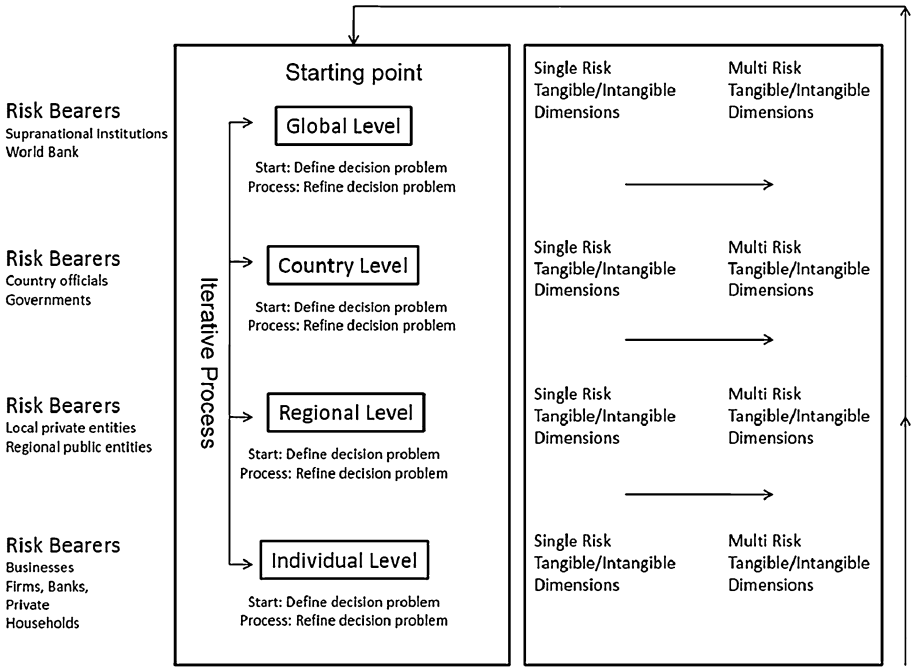

Fig. 1 A process-based decision-making approach. *Source* Adapted from Hochrainer (2011)

In more detail, on each level (e.g. individual, regional, country or international), different sub-political arrangements could emerge, which in the first stage just define their decision problem, for example, single risk (e.g. water shortage due to drought) and multi-risks (e.g. livelihood-related aspects), by itself and afterwards, in an iterative process with other sub-political arrangements, refine their decision problem and possible solutions over all scales. Such a process-based approach seems fruitful as the existence of different levels and scales at which a system can be analysed implies the unavoidable existence of non-equivalent descriptions of it (Giampietro 2003). Consequently, different levels of available and needed information can be expected over different scales. Furthermore, in the case of multiple actors, the fact that there exists multiple social values at different dimensions and scales (Munda 2006) selected strategies may greatly differ and an integrated strategy difficult (or impossible) to derive if only one decision maker is involved. The sub-political arrangements could act as a tool to facilitate consensual decision-making among disputing parties (see successful similar approaches discussed in Verweij and Thompson 2011). This can also create new relationships between different stakeholder groups which can lead to transformative changes at multiple levels. As Balali et al. (2009) presume, reflexive water management encourages collective action that has a participatory rather than hierarchical character. The concept of multi-stakeholder platforms, which has become popular as an institutional framework for resolving complex resource management problems, could be helpful and could emerge through the sub-political arrangements discussed above. Hence, in reflexive water management, multiple stakeholders, who have different interests and needs with respect to water, should organize and arrange water use and conservation issues among themselves through some form of cooperation, including the building of capacity for collective learning and decision-making.

However, complexity should not be underestimated as resource dilemmas in water management do not lend themselves easily to scientific analysis and solutions (Ison et al. 2007). In fact, the interactions are usually complex in many ways; biophysical, social, economic and political issues interact in processes that are only partially path-dependent and usually unpredictable. Their outcomes depend on socially constructed realities and human reasoning which makes them highly uncertain. But this uncertainty is also inherent in the anthropogenic ecological imperatives that humans have unleashed. They also recognize that scientists are no longer the only source of expertise and relevant knowledge dealing with resource dilemmas. SM claims a distinctive space for knowledge-production processes in conditions of irreducible uncertainty and complexity. Hence, water management based on SM would not distinguish between society and nature anymore. The outcome of sub-political arrangement within a process-based approach as discussed above is actually a complex interaction between governmental organizations, citizens, firms and non-governmental organizations (NGOs). Therefore, SM and sub-political arrangements can adequately respond to the Pahl-Wostl (2007) request that "the pressing problems in this field [water management] have to be tackled from an integrated perspective taking into account environmental, human and technological factors and in particular their interdependence" (see also Table 2, column 2 which summarizes the water management aspects under second modernity).

Like other approaches, also the presented one here cannot not be seen as a panacea for environmental problems. While SM is a valuable tool for shaping attitudes, it cannot provide complete answers to all problems or guarantee representation of them in all areas in a satisfactory manner. However, it may serve well as a map to address sustainability within water management in such a comprehensive manner to enable sustainable solutions by reshaping the particular elements of water management regimes and promoting a more transparent negotiating process.

5 Conclusion

The application of the principals of FM has not only achieved high growth and prosperity around the world, but also tremendously increased vulnerability and threatens sustainability now and in the future particularly in water sectors. The recent water crisis in Iran raised questions which are important for both practitioners and researchers dealing with water issues around the world. Specifically, in Iran, there is a growing consensus among key water decision makers and researchers that current water management methods and practices need to make the transition to a more sustainable ones involving an iterative process of continuous improvement on all scales which should include characteristics subheaded under the terms such as, participatory management, collaborative action, decentralization, attention to both hard and soft aspects, networking, information sharing and learning. In this context, a range of solutions are suggested. We summarized the weaknesses of the classical modern water management paradigm and conceptualized a new water management paradigm based on a reflexive modernity which includes sub-political arrangements as the focal point for sustainable water management in Iran. This was based on a comparison of key elements between FM and SM and its application to the current water crisis in Iran. We suggested that the concept of sub-political arrangements within a process-based framework to tackle the water management problems could establish new forms of cooperation over various levels to overcome problems which emerged in FM. Current empirical research on various levels using the presented approach as the starting

point are currently underway, including the assessment of intention and behaviour regarding water conservations strategies of farmers as well as setting up of crop insurance systems.

Acknowledgements We express appreciation to Kathryn Platzer, from Communications Department IIASA, who kindly edited the article

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