Qanat: A Sustainable Groundwater Supply System

Thesis submitted by

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Candidate's declaration

This thesis contains no material that has been accepted for the award of any other degree or diploma in any university. To the best of the author's knowledge, it contains no material previously published or written by another person, except where due reference is made in the text.

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Abstract

Qanat is an ancient Iranian groundwater supply system which has diffused to numerous areas outside of Iran as well. In addition to its eco-friendly techno-physical structure, the Qanat system includes many socio-institutional and ritual dimensions such as Boneh and Qanat marriage rites. The present research reviews the current literature on the Qanat system to investigate the impacts of technical, socio-institutional, and intellectual/ritual aspects of the Qanat system on water resources. This traditional system has been replaced with inefficient technologies and rural institutions through a countrywide change during the 1960s. By including the process of water management modernisation in Iran, a comparative assessment of Qanat and its modern alternatives will become part of this study too. In this way, my research can indicate while the integrated sociocultural and technological system of Qanat sustainably provided water for millennia, contemporary water management systems have been demonstrated to be unsustainable. I draw on a conceptual framework which derives from ecological anthropology and Traditional Ecological Knowledge studies (referred to as "TEK studies" in this research). These approaches provide the most applicable conceptual framework for my project because of their involvement in natural resource management. Moreover, some qualitative research concepts, for instance contextual analysis, are used for understanding the functions of the Qanat system as a sociocultural process. Also, I apply a literature review approach to examine some comparative traditional water systems across the world, together with the process of their replacement with contemporary modern paradigms. The literature review chapter can reveal that the current institutional arrangements of water management suffer from similar problems in many countries. By investigating the collapse of other traditional water systems, I argue that the socio-technical shift of water management in Iran originates from a worldwide transformation in the twentieth century. Based on the study of the Qanat system and other cases, I identify a worldwide distinction between traditional and modern water paradigm. This division framework is useful to categorise and compare opposing socio-technical beliefs and practices of two traditional and modern paradigms. By use of this division, the ways in which the Western-oriented paradigms mismanage water can be discovered more comprehensively. Using the above range of methods and approaches, my study of Qanat intends to fill a considerable gap in the Qanat literature which results from the

dominance of the engineering discourses. I employ the above ideas, concepts, and frameworks to argue that the modern alternatives of local paradigms have been unsuccessful at incorporating local communities into water issues. This means that there is a need to move beyond the mainstream quantitative and technology-centred water management which has divided a holistic body into disconnected elements. My research also suggests some avenues for applying the Qanat system in modern contexts in terms of local communities' engagement in the water management process. In brief, this research can be described as a study of the causes and consequences of the water mismanagement crisis at the Iranian and global scale.

Chapter 1: Introduction

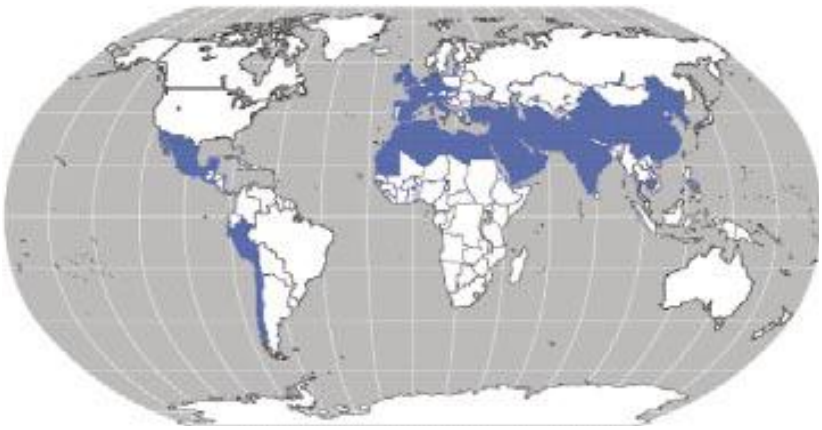
The water crisis is one of the most serious environmental problems currently facing the planet. It is estimated that by the year 2020, two-thirds of the world's population will be living in countries with water problems (WBCSD, 2005). The UN estimates that water shortages will affect half the world's population by 2025 (Strang, 2006). We face a worldwide water shortage that is historically unprecedented. Each year underground water tables are falling and the wells are drying up (Brown, 2007). Iran, having overpumped by an average of 5 billion tons of water per year (IRNCID, 1998), is among many countries over-extracting water from aquifers. Drying Qanats have forced villagers to migrate, creating a wave of "water refugees"in eastern Iran and undermining food production. These problems suggest that modern water management techniques have gone astray and that advanced engineering has not solved the world's water problems (Postel, 2003). Many believe that the solution to the crisis is sustainable water management. Since local knowledge and technology are often well adapted to their environmental contexts, one of the most important ways to achieve sustainable water management is to recognise the value of traditional water technologies and knowledge. This traditional water knowledge can be identified using a range of terms, such as ethnohydrology and traditional water paradigm.

Qanat is an Arabic word that means channel. While the Arabic word of Qanat is used in Iran, the Persian term Kariz is used in Afghanistan; meanwhile, in Syria, Palestine and North Africa, Foggara is the most common term (English, 2004; Lancasters, 1999). Qanat has been called the ancient Iranian groundwater supply system. This system is one of the most significant hydraulic technologies of the pre-modern Middle East and has played an important role in shaping the lifeworlds of villagers in the pre-modern Iranian plateau (English, 1998). The integrated sociocultural and technological system of Qanat has sustainably provided water for millennia. Despite the process of water management modernisation, some Qanats are still in use after thousands of years, comprising more than 170,000 miles of underground channels (Abdin, 2006).

Qanat technology apparently originated in the highlands of western Iran, possibly in connection with early mining ventures in that region (English, 1968). Central Iran –

where Qanats are very old and numerous, and where construction techniques are fully developed – is the core area of the technology and well known for its Qanats (Behnia, 2000; English 1968). But as can be seen in figure 1, Qanats also exist in 34 countries in addition to Iran. The method initially spread to dry land areas of Iraq, Syria, Jordan, Palestine, Egypt, Algeria and Cyprus, but has also diffused to Arabia, the [Persian] Gulf States, Pakistan, Afghanistan, China, Spain, Mexico, Peru and Chile (Cosgrove, 2003). The spread of Qanats in the dry lands of the Northern Hemisphere happened through a few diffusion waves. The first diffusion of Qanats out of their core area occurred in the Persian Achaemenid Empire period when the Persians (Iranians) established an empire extending from India to the Nile. To the west, the Persians carried Qanat technology across the Fertile Crescent to the shores of the Mediterranean and southward to Egypt and Saudi Arabia (English, 1968). In a second major diffusion, Qanat technology spread with Islam and the Arabs across North Africa into Spain, Cyprus and the Canary Islands in the 7th and 8th centuries A.D. (English, 1968; Behnia, 2000). This technology has spread into Europe with Arab culture; Qanats were used marginally in the Spanish province of Catalonia and Madrid. Recently, abandoned Qanats were discovered in Central Europe, in Bavaria and Bohemia, though when or how Qanats spread into those regions is as yet unknown (English, 1968).

Map 1 Distribution of Qanats around the World (in blue) (Abdin, S. 2006)



Research Questions and Aims

I have developed two sets of research questions and aims to understand different aspects of the Qanat system within both pre-modern and contemporary contexts. Firstly, I try to answer the question: how do different aspects of the Qanat system (technical, socio-institutional, and intellectual / ritual levels) affect water resources? Secondly, my project addresses the question: are various levels of Qanat system more eco-efficient than their counterparts in modern water management? (The modern counterparts of the Qanat elements include deep wells and modern rural cooperatives). For this purpose, the main focus will be on the social system associated with Qanat, called Boneh. Moreover, the Persian and English literature on Iranian ethnohydrology has been used for very different purposes which mostly contain engineering discourses. Therefore, by integrating techno-physical and socio-cultural dimensions of the system I can create a holistic understanding of all levels of the Qanat system. By responding to the above questions, this research can contribute to understanding the socio-cultural complexities underlying water management problems in Iran. For this purpose, I implement some qualitative methods from general qualitative research discourse in social science to realise the subjective aspects of the Qanat system. Furthermore, I use various ecological anthropology theories to explain existing literature on Qanat. Meanwhile, the formulation of general recommendations for a model of social/technical co-management based on the Qanat system are the practical aims arising from this research. Regarding the practical aims, my focus will be on the patterns which can be learnt from the social/institutional aspects of Qanat to incorporate local communities into the water management process. My research suggests some avenues for applying the Qanat system in modern contexts in terms of local involvement with the water management process. Furthermore, this thesis is not based on fieldwork, rather on the analysis of Iranian documents on Qanats. Therefore, one of the main contributions of this study is analysing the Persian documents which have never been assessed in English language studies of water management systems, in relation to a theoretical framework drawn from ecological anthropology.

Chapter two covers the social science disciplines and approaches that I use in my research. Ecological anthropology, ethnoecology (Traditional Ecological Knowledge)

and qualitative methods are the three main approaches around which I develop my theoretical and disciplinary perspective. In chapter three, I review three traditional water systems across the globe. In chapter four, the set of techno-physical, social and ritual practices around Qanat are described. In addition to the physical structure of Qanat, the Boneh system as the social institution and the Qanat marriage as the ritual aspects are examined. Meanwhile, following the contextual method of qualitative research, rural life in pre-Capitalist Iran is also investigated as the general non-water-related context of the Qanat system. In chapter five, I describe the technical and social levels of modern water management, the paradigm that contains deep well technology along with modern rural institutions. Furthermore, the overall shift in the water paradigm in modern Iran is understood more comprehensively within the larger context of the White Revolution and particularly the Land Reform Law of the 1960s.

Chapter six offers a discussion of themes and conclusions arising from the study of the Qanat system. In addition, this chapter includes a discussion of a division between the Qanat system elements with their modern alternatives in Iran; also, the tension of old hierarchies and modern egalitarian agriculture. Chapter seven offers a discussion about the worldwide distinction between traditional and modern water paradigms which has resulted from the Westernisation of water management in the twentieth century. For chapter seven, I implement the same four-level classification which is used for the some other chapters. Chapter eight includes some general suggestions about a possible water co-management model. These recommendations mostly concern the organisational principles and local values regarding water management rather than technological patterns. At the end of chapter eight, I argue about the applicability of the Qanat system in a contemporary context.

In the following chapter, I intend to discuss the methods and disciplines that are used to investigate my research problems.

Chapter Two: Discussion of Methods

Chapter introduction

This chapter describes the social science disciplines and approaches which I use in my research, together with their applications to the questions and aims of my project. Ecological anthropology, ethnoecology (Traditional Ecological Knowledge TEK) and qualitative analysis shape my theoretical and disciplinary viewpoint. Since water management has been one of the main topics within this field of TEK studies; so, this field contains many useful frameworks and ideas concerning a holistic and qualitative approach toward water management. The four-level analysis is the main framework within TEK studies which has been developed to operationalise the holistic strategy of the field. I use the four-level framework to integrate all aspects of Qanat into a cohesive paradigm. I use this four-layer framework to create a comparative distinction between the traditional and modern water paradigms. Also, a quick review of criticisms of both ecological anthropology and TEK studies are among the steps that I take in this chapter. Recognising the disadvantages of TEK leads to a balanced comparison between traditional and modern water paradigms. This balance is crucial for my theoretical questions and practical aims.

Theoretical framework and conceptual underpinnings

Most ecological anthropologists are interested in particular forms of resource management such as irrigation, fishing and hunting (Bates& Lees, 1990). Accordingly, the important advantage of ecological anthropology for my research is that some specific subfields have been developed by ecological anthropologists for every aspect of the ecosystem including water. TEK studies and ethnohydrology are subfields that concentrate on traditional water management systems. Ecological anthropology research also has been done in localities with special environmental conditions like drought; in other words, in environments that have been described as harsh (Bates and Lees, 1990). This approach has much potential for examining human responses to water shortage. My specific analytical tools come from TEK studies which is an approach within ecological anthropology. The specific tools and

arguments in water-related subfields will be described later through the chapter. Before going into the details of my research, some general guiding ideas can be seen in ecological anthropology literature. These guiding ideas are mostly about culture-nature relationships and are relevant to the questions, aims and water management cases of my study.

Ecological or environmental anthropology is a subfield of anthropology focusing on human interactions with their environment. Although ecological and environmental anthropology are often used interchangeably, there are some differences between them. Ecological anthropology can be defined as: "a particular type of environmental anthropology describing a single ecosystem which involves a human population and mostly dealing with small populations. Ecological anthropology identifies populations not cultures as the study unit" (Townsend, 2000: 103; Argyrou, 2005: 42). Meanwhile, environmental anthropology is closer to applied anthropology and aids policy-making and program planning by combining knowledge of ecology with methods and tools for understanding the social and cultural dynamics of communities potentially affected by policy decisions. The body of knowledge in environmental anthropology is broader and more extensive (Argyrou, 2005). Like many other researchers, I will use ecological and environmental anthropology interchangeably here, as the closely related terms denote a subdiscipline of anthropology. Despite some criticisms which will be explained later, this subdiscipline provides an effective approach to contemporary problems in natural resource management. Ethnobiology, ethnobotany, ethnozoology, ethnoecology, spiritual ecology, historical ecology, political ecology and human evolutionary/behavioural ecology are among the most recent approaches that have shaped contemporary environmental anthropology (Moran, 2000).

This anthropological approach has focused on the relationships between cultures and their natural environments/ecosystems and their mutual impacts on each other. Ecological anthropology investigates culture as a building-block of human ecosystems. Some anthropologists regard culture as a thing-in-itself without regard to its connections to the environment (Townsend, 2000) and claim that culture is something that should be understood only within the context of culture itself (Sahlins, 1976). On the other hand, ecological/environmental anthropologists have considered

culture as a "tool-kit for survival in a particular place on the planet" (Townsend, 2000; Bates and Plog, 2003). Specifically, some ecological anthropologists have identified populations, not cultures, as the "adaptive units" that respond to the environment and form the basic units of the ecosystem (Townsend, 2000; Milton, 1998). Briefly defined, this anthropological sub-branch studies the methods by which human populations form the environment as well as the ways in which social, cultural, political and economic life are specified by the natural environment (Salzman and Attwood, 1996).

Current ecological or environmental anthropology is specifically the product of the neo-evolutionism era in American anthropology, which was shaped primarily in the 1930s in response to the domination of functionalism and Boas's historical school (Bates and Plog, 2003; White, 2000). New ecological anthropology attempts to achieve a reasonable assessment of culture-nature relationships. This balance includes rejection of both environmental determinism and functionalist viewpoints. The rejection of the deterministic notions implies that intellectual beliefs do impact on the objective world. On the other side, ecological anthropology disagrees with some functionalistic viewpoints such as Franz Boas's historical particularism which explains culture by culture without regard to its connections to the natural environment (Ibid). Despite the above-mentioned linear approaches, a widely-accepted principle of new ecological anthropology connotes mutuality of culture-ecosystem relationships. This principle insists that environmental conditions create socio-cultural institutions, as much as culture shapes natural landscapes. In fact, ecological anthropology explains human society and culture as a product of adaptation to the concrete environmental circumstances (Seymour-Smith, 1986), while the field discovers the ways in which culture affects ecosystems. This mutuality principle has been a base for developing subfields such as TEK studies to investigate the effects of the cultural and even perceptual/ritual dimensions of traditional natural resource management on the real world. When it comes to evaluating the relationships of various levels of an ehtnohydrological system with water resources, the mutuality principle becomes very relevant. According to this mutuality, water scarcity develops some socio-cultural institutions and perceptions in a given community as much as culture impacts on the different elements of community's ecosystem. In this way, social-ritual-intellectual levels of TEK systems are not just inactive products of an

ecosystem but each of them in their turn affects the ecosystem. Since my research topic is the relationships of socio-cultural levels of Qanat knowledge and the ecosystem; therefore, ecological anthropology can clarify the mutuality of nature-culture relationships in the case of socio-cultural regulations of water resources.

Julian Steward had a great role in the development of anthropology in America in the 1950s and 1960s through his cultural ecology theory. He has been the most prominent figure at the early stage of ecological anthropology. The Stewardian style of cultural ecology has been applied to the study of hunter-gatherers, preindustrial farmers, pastoralists and contemporary rural societies (Moran, 2000). Until Steward's time, human-habitat theories lacked empirical research. Cultural ecology put the emphasis on careful analysis of social interaction, recording the movement and timing of work activity to arrive at cause-and-effect relationships. Also, comparative method was the trademark of his approach (Moran, 2000; Milton, 1998). According to Steward, people's socioeconomic organisation is a result of using certain technology to exploit a particular environment (Townsend, 2000). Many of Steward's students and other anthropologists picked up his concepts, even if they used other names. As a result, "cultural adaptation" became a major theme in anthropology (Townsend, 2000). Although Steward's contribution to understanding human-environment interaction is undeniable and possibly greater than anyone before (Moran, 2000), dissatisfaction with deficiencies of his approach led researchers to begin adopting an ecological framework influenced by the field of biology (Moran, 2000).

Harold Conklin invented the term ethnoecology, the primary subfield informing my research approach (Netting, 1986). He is widely known within ecological anthropology for giving complete descriptions of the wide and detailed knowledge of plant and animal species, climate, topography, and soils that makes up the ethnoscientific repertoire of indigenous food producers (Ibid). Clifford Geertz also was one of the first anthropologists who used the ecosystem as a unit of analysis in cultural anthropology. Following Geertz's use of the ecosystem concept, some anthropologists adopted a holistic model of systems theory to investigate interrelations within a human ecosystem (Moran, 2000). Marvin Harris's famous theory – cultural materialism – along with Leslie White, Elman Service and Marshall

Sahlins's works have also been counted as a part of the broader literature of ecological anthropology (Ibid).

Other ecological anthropologists have contributed ideas that are specifically more applicable to my question of the role of ritual regulation in water resource management. Andrew Vayda and Roy Rappaport were the anthropologists who coined the term ecological anthropology (Hardesty, 1977). Emphasising the application of ecological sciences, Rappaport and Vayda preferred the term ecological anthropology to cultural ecology (Ibid). Because of dissatisfaction with some weaknesses in Stewardian cultural ecology, certain scholars proposed a more satisfactory methodology, data-collecting techniques and analytical tools which came from biological ecology. Ecological anthropology was the result of these efforts (Moran, 2000). Rappaport wanted to unify ecological anthropology with general ecology. He pointed out that all the components of an ecosystem were linked by the mutual exchange of matter and energy. Perhaps Rappaport's most influential contribution was the rejection of Durkheimian viewpoint that the only function of religion and rituals is to bind community through shared symbols (Lansing, 1991). Rappaport's widely-known study, "Pigs for the Ancestors", is a classic example of investigating rituals role in natural resources management. Since Rappaport could show how rituals play a central role in the maintenance of a society's balance with resources, his findings caused a new respect for the traditional knowledge systems. His work later became one of the principal contributions to studies of Traditional Ecological Knowledge systems and the subfield of ethnoecology (Moran, 2000; Townsend, 2000). As we will see later, some strategies and analytical tools of TEK studies which are used in my study such as the four-level framework, benefited from Rappaport's idea about regulatory role of beliefs and rituals. As one of my research questions is what role ritual practices of the Qanat system play in water management, Rappaport's idea becomes explanatory in my work. In this regard, in chapter four I will discuss how the Qanat marriage ritual plays a role in a community's relationship with its water resources.

Criticisms

Ecological anthropology has been subject to criticism on various grounds in recent decades because of its overemphasis on some ecosystematic variables such as equilibrium and energy. Since later ecological anthropologists adopted the ecosystem concept as the basic analytical framework (Gross, 1990), criticisms about ecological anthropology were directed mostly to the ecosystem approach in anthropology. Opposing scholars from various viewpoints, both outside and sometimes within ecological anthropology (Bates and Lees, 1990), described ecological anthropology as deterministic, materialist, overemphasising energy, ignoring history, of neglecting the role of the individual and of being equilibrium-centred (Moran, 1990; Gross, 1990). Like materialist and political economic paradigms in anthropology, ecological anthropology also investigates cultural behaviour in its environmental context (Gross, 1990) and emphasises the importance of production and exchange. As a result of this approach, ecological anthropology has been labelled as "vulgar materialism" (Ibid: 164). But I contend that not all of the criticisms of ecological anthropology are justified. Current ecological anthropology and its subfields such as TEK studies distanced themselves from some one-dimensional explanations of culture-nature relationships. The charges against early ecological anthropology mostly do not apply to current ecological anthropology and TEK studies. These fields today are holistic, qualitative, and have a multi-factor analysis approach compared to the old-fashioned determinism of the early ecological anthropology. Despite some shortcomings pointed out by critics, environmental anthropology is required for deep understanding of mutual human-environment relations. Ecological anthropology promotes a useful holistic study of humans in their biophysical environment (Moran, 1990). Nevertheless, the criticisms of ecological anthropology can give us a general perspective about the shortcomings of the discipline in the past decades. I will indicate to what extent the charges are justifiable and how ecological anthropologists have reacted to those criticisms by balancing their approach.

The tendency to endow the ecosystem with the properties of a biological organism is maybe the most substantial criticism of ecological anthropology. This tendency means that ecological anthropologists view the ecosystem as an organic entity which has properties such as self-regulation, maximisation of energy and strategies for survival.

This trend caused past anthropological ecosystem studies to neglect the capacity of cognitive dimensions of human behaviour to transform the physical environment through their social activities (Baines, 1989) and overemphasised the self-regulatory features of an ecosystem. Today, ecological anthropologists do not believe measuring energy flow in ecosystems is a central concern; hence, many scholars describe human-environment relationships without assuming the self-regulating properties of the ecosystem concept (Bates and Lees, 1990). Furthermore, in response to shortcomings about cognitive aspects of human activities, some subfields of ecological anthropology such as ethnoecology/ TEK studies are investigating the impacts of humans' cognition on their ecosystems. Another criticism is ignoring time, historical process and structural change as a result of overemphasis on stability in ecosystems. These critics argue that an ecosystemic point of view is equilibrium-centred (Baines, 1989). But according to Ellen and Netting, attention to history is not incompatible with ecosystem research in anthropology (Milton, 1998: 45). The recent inclusion of the historical dimension in ecosystem studies recognises both the processes of stability and change in human ecosystems. Accordingly, the field has shifted from synchronic to more diachronic ecological anthropology and is finally moving beyond equilibrium-centeredness (Moran, 1990). While ecological anthropology may "have led some investigators astray" (Moran, 1990: 310), as will be described below, it has experienced considerable progress in its approach. In the final analysis, this approach is more explanatory than some naive assumptions of earlier ecological anthropology (Bates and Lees, 1990). In fact, if some opponents' approaches, such as the assumption that "culture comes from culture", are accepted and applied, anthropology will return to 1915 (Gross, 1990). The lack of a conceptual framework outside environmental anthropology for examining complex relationships between humans and their natural environments suggests that there are no better analytical alternatives for studying water management.

The deficiencies discussed above have carefully been avoided in recent ecological anthropology trends. The new ecological anthropology that is used for my study is not influenced by the old-fashioned approaches which were subject of the above-mentioned criticisms. Ecological anthropology has led recent development of new analytical frameworks and as a result nearly all sub-fields of anthropology have been influenced by the ecosystem approach (Moran, 1990). Inclusion of cognitive

dimensions of human behaviour in TEK studies and its analytical frameworks is one the most important advancements. This development enables ecological anthropology to investigate neglected perceptional/ritual layers of traditional natural resource management systems. Thus, this approach can bring a rich perspective to resource management, and can re-introduce knowledge of the pre-industrial ways of intensifying production without environmental degradation (Johnson, 2000; Earle, 1987). Ecological anthropology contributes to the development of extended models of sustainability for humankind. Through research and study with indigenous peoples in an ecological framework, anthropologists learn more about intimate interactions between humans and their environments (Moran, 1990). One area of ecological anthropology that shows the most promise is in explaining how local groups cope with hazards, which is widely useful for development planners (Bates and Lees, 1990). Ecological anthropology has gone through different phases, during each of which the field has emphasised environment, culture, techno-environmental features, energy flow and so on. Finally after many improvements it is highly relevant to the present environmental crises and natural resource management.

The strong involvement of ecological anthropology in natural resource management including water, locality of the major studies in the field, guiding ideas about mutuality of the culture-environment relationships, investigation of impacts of rituals on natural resources and so on make this field relevant to my project. Ecological anthropologists' involvement in natural resource issues makes them aware that many environmental events originate from policy decisions and centralised planning which are regarded as "the hazards of development" (Bates and Lees, 1990). These findings can be used to investigate negative impacts of modern water management. So this approach can offer recommendations for water policy as much as it answers some theoretical questions about cultural complexities underlying water resource management. The fact that ecological anthropological studies have been done with regard to special local conditions means that they are useful to my study. Since TEK systems are localised models of managing resources, this focus of the field on particular locations overlaps with the local characteristic of all TEK systems. The local focus of ecological anthropology research can contribute to my practical aim which is offering a model of decentralised local water management. For the reasons outlined above, ecological/environmental anthropology is the most relevant

theoretical frame of reference for a social scientific study of water management. Therefore, I employ it as one of the primary approaches in my study.

Ethnoecology and Traditional Ecological Knowledge (TEK)

Ethnoecology has been defined as: "understanding how nature is seen by human groups [indigenous people] and how in terms of their images they use and manage natural resources" (Toledo, 1992: 2). Ethnoecology has developed out of ecological and environmental anthropology as an independent study area and effectively combines the intellectual and practical aspects of traditional natural resource management through the integrative study of beliefs, knowledge and practices of a given social entity (Barrera-Bassols and Toledo, 2005; Toledo, 1992). Also, Traditional Ecological Knowledge (TEK) is a similar and closely related field to Ethnoecology. TEK can have two different meanings. The term TEK studies refers to a field related to anthropology which has been developed to study traditional natural resource management systems, while TEK connotes the actual management systems themselves. In my thesis, the first connotation of TEK (TEK studies) is considered. Moreover, within the TEK literature "traditional" is regularly equated with "indigenous".Ethnoecology covers subfields like ethnobotany, ethnohydrology and ethnozoology. The hydrologic subdiscipline of ethnoecology is ethnohydrology which means "ethnoecological knowledge on water "(Sangkhamanee, 2007). Since ethnohydrology is not counted as a separate field within ethnoecology, this term is not in wide use, but sometimes I will apply it instead of traditional water knowledge in this study. TEK involves attachment to the local environment, importance of community, spiritual and religious dimensions and a large moral and ethical context. By contrast, Western scientific knowledge is characterised by universalism, individualism and an instrumental attitude toward nature (Berkes, 2008; Burnaby, 2003). Recently anthropologists began to investigate indigenous "ecological rationality" and the role it plays in resource management as a "regulator mechanism" (Toledo, 1992; Sangkhamanee, 2007). One of the main promises of ethnoecology is overcoming the modern "structural separation" (Lansing, 1991: 130). This division refers to the current separation of the intellectual and practical components of a knowledge system (Toledo, 1992). To eliminate this problem, TEK studies considers

many neglected cognitive dimensions of human behaviour, in terms of their impacts on natural resources management (Moran, 2006). Holism, comparativeness and complementarity with modern natural resources management are the main features of TEK studies which, in addition to some productive criticisms, are beneficial for my work.

Holism in TEK studies is concerned with the interaction between intellectual and practical dimensions of indigenous knowledge. TEK studies have overcome the divorce between intellectual and practical components of a knowledge system (Toledo, 1992). This ethnoecological holism has been one of the main promises of the field. Ethnoecological holism is based on the position that the "structural separation" in modern societies should not be implemented in relation to indigenous groups (Lansing, 1991: 131). This separation when applied to traditional knowledge becomes more misleading, since indigenous knowledge components have closer interconnectedness. Holism in regard to my first question helps my research to investigate simultaneously all the levels of the Qanat system and integrate practical and intellectual aspects of water management. This requires overcoming the mentioned "structural separation" which can be one of the main contribution of ethnoecology. This "structural separation" has led to major shortcomings in understanding of Qanats in Iran. Due to the lack of a holistic approach in Qanat studies, investigations have mainly focused on the technical system of Qanat (by technical I mean the physical system of a technology). Without regard to a few exceptions, many scholars even in the Qanat-related fields are not aware of the existence of Boneh, which is the social collective system related to Qanat. A holistic approach can concurrently consider neglected sociocultural regulations of Iranian traditional water management in conjunction with related technical dimensions.

Comparative analysis is another feature of ethnoecological research. Comparative analysis of many case studies means we can extract some conclusions to arrive at a comparative analysis by evaluation of ecological efficiency of indigenous productive systems (Toledo, 1992). Because of my second question which concerns an eco-efficiency comparison between traditional and modern water management in Iran, the research has to take this comparative viewpoint. Regarding this comparison, I create a

traditional/ modern division in water management to match up the elements of each paradigm that have the same purpose in both paradigms. In addition, I develop a comparative approach in my ethnographical case studies chapter, since one of my goals is offering cross-cultural lessons from the result of studies about other traditional water systems in other areas of the world.

The complementarity of TEK with Western scientific knowledge, which sometimes has been called joint-management or co-management, is an increasingly important issue in ethnoecology (Buranbay, 2003). Although resource management has been too Western-centric until recently, TEK scholars do not intend to eliminate Western knowledge. Despite some criticism, TEK researchers have not suggested we should let tradition lead us back to ancient times (Johannes, 1989). They believe in the complementarity of the two systems despite their differences (Berkes, 2008) and their argument is primarily directed at combining local principles of resource management with modern management. The recommendations of TEK researchers are focused on the methods of collaboration between TEK and Western-oriented resource management. Disadvantages of TEK systems should be taken into account in this cooperative model of joint management. This complementary approach of TEK studies toward modern resource management contributes to my recommendations about technical/social co-management.

There seems to be a consensus about multiple levels of TEK, even though there are disagreements about the delineation of these layers (Berkes, 2008: 17). Berkes (2008) considers traditional knowledge at four interrelated levels, so his four-level framework can efficiently organise all dimensions of TEK systems according to a systematic order (see figure 1). Therefore, I choose Berkes's four-level analysis as an organising framework to investigate the Qanat system and some similar cases. The first level contains local knowledge of environment, or the "corpus" which includes information, taxonomy, et cetera. Taxonomy can be defined also as the way people name and classify plants and animals and other objects, or the hierarchical arrangement of terms according to levels of generality (Townsend, 2000). In these native systems, items are classified on the basis of how they contrast with one another. From these contrasts, one can realise which features are important for people and which are not (Moran, 2000; Hardesty, 1977). The study of native terms and

categories is not only a matter of matching up scientific labels to local language names, but also includes identifying what features of objects people classify and name (Townsend, 2000). These indigenous classification hierarchies refer to particular aspects of the environment such as soil types, plants and animals (Barfield, 1997). The second level of TEK is the resource management system which equals the technical element of TEK. The third layer covers appropriate social institutions, rules, and customs: in other words, the social organisation according which groups of local people should cooperate to manage their resources. Finally, the worldview which shapes environmental perceptions and meanings is the last and most abstract level. This fourth level includes a set of intellectual elements such as religion, ethics and belief systems (Berkes, 2008). These four levels of TEK are not always distinct, particularly the technical management and social institutional level which intersect deeply and can be counted as the coupled levels. These two tied layers also have been called 'praxis' and consist of all the technical and social practices for managing a natural resource (Toledo, 1999). There is also feedback among the levels that enable them to adapt and grow due to the new environmental conditions or other changes. To summarise this framework, the levels that used to be studied unconnectedly as a result of modern natural resources management are integrated within this four-layer analysis. The diagram of the next page explains these four levels.

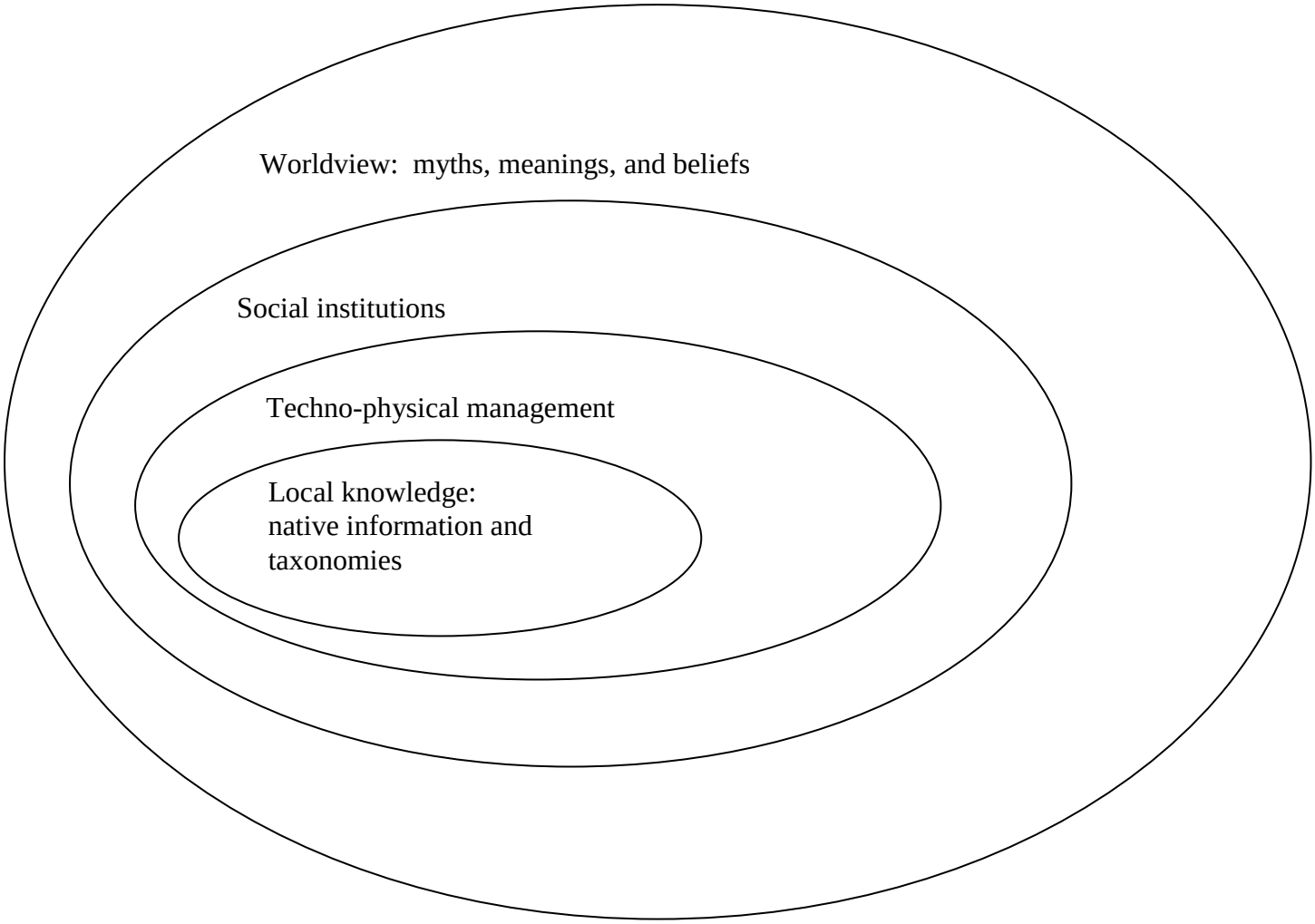


Figure 1. Diagram of the four levels of TEK systems

The four-level analytical framework mentioned above has the potential for applying the holistic strategy of TEK studies at the operational stage. By this framework we can merge the aspects of resource management systems which were treated separately by the modern water paradigm. Since we are dealing with all dimensions of traditional water knowledge in Iran, this four-level framework can show how to realise and classify different levels of local water knowledge, and how to explain the internal dynamic of water knowledge segments. Concerning my question about ethnohydrology impacts, the four-level framework can recognise and classify all the

elements of the Qanat system. Furthermore, we can think of inter-level feedback to understand the internal dynamic of the four layers of the Qanat system. In addition, it should be pointed out that the second and third levels of TEK (technical and socio-institutional levels), which have also been called coupled levels or praxis, are the primary focus of my study in terms of research questions and practical aims. Regarding the application of the four-level framework to my second question, the four-level framework can identify the counterparts of Qanat elements in modern water management, and we can match them up. The framework essentially has been developed for merging the parts of TEK systems, but in my research it is also used for combining all levels of the Western water management into one combined paradigm. My second question requires a comparative assessment of traditional and modern management. To make this comparison, I use the four-level framework of TEK studies to create a modern/traditional division in water management based on the characteristics of both systems. I use the four-level framework of TEK studies to create this division. This distinction will be developed and discussed through the next chapters.

The traditional and modern water paradigms that make up the division mentioned above have opposing elements which are radically different. As a result, this division exists between traditional and modern water systems both in the Iranian case and at the worldwide scale. To investigate this opposition in a more organised way, I create a model of division between two paradigms. The four-level framework is a model to put this division in order. According to this model, each side of the traditional/modern division consists of four levels of its own. In this way, the division includes an outline of internal elements of two systems in comparison to each other. This classification indicates characteristics of both traditional and modern systems at four levels. The division can indicate how every inappropriate element at each level of modern water management has negative impacts on an environment. On the other side, the division is able to show how each inappropriate perceptual and social feature of the modern paradigm may be prevented in the Qanat system. And finally, how each factor of the modern paradigm plays a role in water mismanagement and how its traditional counterparts in Qanat system have prevented these negative effects. The division of the Qanat system and its opposing paradigm will be located in the argument and analysis chapter. Also, the worldwide division between traditional and modern water

systems will be discussed in the general conclusions chapter. Regarding other applications of the four-level approach, the four-layer analysis is valuable from a sequential historical point of view for explaining concurrent changes to all the elements of water knowledge during transition from traditional to modern management. The four-level framework of TEK studies, by systematic organisation of non-technical dimensions of water management as parts of an integrated body, clarifies that water problems are not only technical problems. In the same way, the framework can demonstrate that the water crisis mainly originates from non-technical levels of water management which include dysfunctional socio-cultural structures of contemporary water management. So, techno-physical and social levels (level 2 and 3) of this framework can be used to arrive at the socio/organisational solutions for incorporating locals into water management. By learning from traditional meanings and ideas attached to water at the intellectual level of TEK (level 4), we can identify the problematic environmental perceptions inherited in the modern water paradigm.

Criticisms of TEK studies

Warning about misapplication of TEK, some cases of overexploitation of resources by indigenous people, excessive claims about indigenous wisdom, romantic and uncritical appreciation of traditional knowledge, idealism (Baines, 1989; Berkes, 2008; Johannes, 1989; Hardesty, 1977) have been among the warnings and criticisms about this field. But these critiques have not prevented the wide use of the approach and mostly they have shown the extent to which TEK can be implemented in contemporary contexts.

TEK studies, since the earliest stages of development, have been subject to criticism from both outside and inside the field. Harris takes a materialistic stance on ethnoecology. He fears that stress on informants will lead to idealism, which is at odds with his materialistic description of culture. Also, Rappaport states that the environment, as it is reflected in the understanding of local people, differs from “the operational environment”. Rappaport and Vayda together argue that the operational environment is more complex than “the cognized environment” which is comprehended by a group (Hardesty, 1977).

More recent critics have indicated some misleading assumptions within TEK studies. Their argument is that considering some cases of overexploitation of resources by tribal people, traditional lifestyle is not necessarily always more eco-efficient than its modern counterpart. A classic example of this traditional misuse is "ancient extinction" of animal species as a result of tribal people's human activities (Berkes, 2008). So, caution is necessary in generalising about the environmental efficiency of traditional knowledge systems. Misapplication of traditional knowledge without attention to the modern context requirements has been another criticism. But despite this criticism, existing TEK literature indicates that the knowledge contained in local traditions is applicable to contemporary resource management problems (Ibid). "Excessive claims of indigenous wisdom" (Berkes, 2008: 232) within ethnoecology has been pointed out as one the shortcomings of the field. Some critics have argued that there is a stereotype of indigenous people among Western environmentalists as people who never do wrong and that their traditions are always adaptive (Ibid). Also, opponents have reminded that romantic and uncritical appreciation of TEK and traditional values is unhelpful and as damaging as dismissing TEK. The argument is that the co-existence of wise and unwise environmental practices can be seen in some traditional cultures (Johannes, 1989). Indeed, some of traditional management systems can work well mostly because of low human population and they would be unlikely to solve today's resource management problems.

These cautionary comments don't mean that TEK studies should be abandoned but they indicate the extent to which we can learn some lessons from it. Certain scholars have claimed that the belief in sustainability of some human practices and cultural phenomena is just "the myth of primitive ecological wisdom" (Milton, 1996: 353), and is merely a support for political arguments against industrialism and in favour of autonomy for indigenous communities. Consequently, it is difficult for some modern resource managers to accept that they can learn something from a parallel system of knowledge which is superior in some aspects (Johannes, 1989). In spite of the mentioned resource managers, much traditional knowledge is useful and applicable to modern contexts (Baines, 1989); so, the feasibility of TEK for solving contemporary resource management problems has been gradually recognised in the various parts of the world (Berkes, 2008). Combining TEK with modern systems is rapidly gaining

recognition and the complementarity of the two systems is widely accepted by many decision makers and development planners (Burnaby, 2003). Ethnoecological research now involves sophisticated studies showing how cognition affects how we use the environment (Moran, 2000). Significant findings of integrated "knowledge-practice-belief complex" (Lewis, 1993) and its centuries of experience is something more than the concept of knowledge as information and content; thus, it can help us to deal with the major issue of our time which is how to develop a sustainable relationship with the environment.

Some defensible criticisms of ethnoecology, such as the claim of excessive wisdom, possible TEK misapplications to modern societies, and the fact that traditional ways are not always adaptive, are relevant to my work. Criticisms of TEK studies help me to have a balanced judgment regarding my second question (are various levels of the Qanat system more eco-efficient than their counterparts in modern water management?). As we will see in the Qanat chapter, lack of a balance in comparing Qanat with deep well system has led to groundless judgments of two conflicting groups in Iran (Behnia, 2000). These criticisms remind us of cases of traditional misuse and hierarchical inequality that we should take into account to avoid prejudices in favour of the Qanat/Boneh system. Acknowledging some cases of resource misuse by traditional people can bring more attention to some disadvantages of the social and technical system of Qanat which facilitated its abandonment. Awareness of TEK disadvantages prevents romantic and uncritical appreciation of Iranian ethnohydrology and also misjudgements in evaluating ecological efficiency of the Qanat/Boneh system. While I intend to apply the organisational and social patterns of a TEK system to a contemporary egalitarian context, remembering misapplications of TEK in contemporary societies helps for arriving at a realistic model of local and community-based management. Every model of locals' engagement in water management should take place with regard to the requirements of a modern context. Since I aim to offer a co-management model, TEK criticisms prevent the recommendations based on stereotypes about hydraulic traditions and local people.

The holistic, four level, comparative, complementary approach of TEK studies to modern natural resources management, and awareness of criticisms about

ethnoecology/TEK in terms of excessive claim of wisdom and misapplications to the modern context are some of relevant concepts of this field for my study. At the same time, there have been some misleading assumptions in ethnoecology particularly when it comes to the second question of eco-efficiency comparison and practical aims of co-management models. Thus, we can not claim that TEK is a total replacement for modern natural resources management and I have tried to show how each of these issues in ethnoecological research is helpful in my own.

Applicability of qualitative methods to ethnoecological research

There are many overlaps between TEK studies and the larger qualitative research literature in the pre-TEK social science, in the sense that TEK studies is essentially one of the most qualitative subfields of ecological anthropology. In contrast to supposedly value-free viewpoints of quantitative approaches, qualitative research and TEK studies cover moral and subjective components. Qualitative research investigates people's activities in their local context in the same way that TEK studies examine local and temporal particularities of concrete cases. Qualitative trends in social research connotate a return to the local systems of knowledge and to the context in which they are embedded (Flick, 2006). Subjective meanings which people attribute to their practices and environment include another common topic of TEK studies and qualitative approaches. Above descriptions mean that TEK studies includes a large number of non-technical, context-related and subjective variables in addition to the physical system of a technology. Water management as a socio-cultural phenomenon has lots of in-depth and socio-cultural elements which have been neglected for decades of quantitative natural resources management. A possible quantitative/statistical method for answering my questions should look like the method Rappaport followed to evaluate the impacts of rituals on the environment in "Pigs for the Ancestors" (Rappaport, 1967). His method includes measuring ecosystematic changes caused by independent variables. But this type of quantitative assessment of the Qanat technology and its associated sociocultural relationships requires reliable and comparable data and also detailed statistical calculations. This kind of data and calculations are not possible within the confines of this research project.

A holistic study of my topic requires investigating a large number of variables of TEK, but a quantitative method rarely can investigate as many qualitative dimensions as TEK approaches have been able to. The number of variables in quantitative method should be very restricted in order to examine statistical correlations of two or couple of variables. Due to the restricted number of variables in quantitative methods, my questions about the socio-cultural dimensions of Qanat system cannot be answered by statistical calculations. My research questions require understanding the ways in which the most qualitative and subjective levels of Qanat system such as water perceptions, animistic beliefs and rituals impact on water use and management patterns. The emphasis on processes and meanings in qualitative methods helps investigating water management as a social process rather than purely an engineering and technical phenomenon. Consequently, qualitative methods are more in agreement with the holistic nature of traditional water management. Due to the qualitative nature of TEK studies plus difficulties and shortcomings of quantitative study in water management, a quantitative method is not appropriate within the confines of my research. Therefore, I have chosen qualitative techniques such as contextual and interpretive analysis for my study.

Specific qualitative concepts: contextual and interpretive approach

Models and concepts have been developed by qualitative researchers in social science many decades before ethnoecology. I can benefit from and integrate them into my ethnoecological plan. The qualitative research techniques which are most useful to my work are contextual in-depth analysis and interpretive approach. A contextual analysis focuses on the third level of TEK that is social institutional level of a traditional knowledge system. Using an interpretive approach, qualitative investigators can get closer to the actors perspective. Actors' perspectives in my research contain water beliefs and meanings which are located at the fourth level of a traditional knowledge system (intellectual level).

Modern water mismanagement partly originates from ignorance about the sociocultural context of technology, and this unawareness is a result of the dominance

of quantitative and technical discourses which disregard the social context. The problem can be challenged by the contextual analysis. The contextual approach investigates the social context of technology; consequently, qualitative method helps us to arrive at a holistic picture of water management. Contextual analysis requires collecting large amount of in-depth information about social context of one or a few cases, in this way we can realise concrete social settings of the particular people who use a technology system. Owing to this contextual technique, qualitative researchers place parts of social life into a larger whole, so this method contributes to the understanding of water management a part of a larger whole; consequently, as a sociocultural phenomenon.

To connect contextual analysis to the Qanat system, I use contextual analysis of qualitative research at two stages. First, according to this technique, a researcher should study water-related contexts of Qanat technology. These factors of Qanat system are socio-institutional and intellectual/ritual aspects of the system. This stage of applying contextual analysis includes studying all the technical and non-technical layers of the Qanat system. At the second stage, inspired by this technique, I investigate some non-water-related contexts of the Qanat system which do not play a direct role in water management. For this purpose, I should investigate other social aspects of Iranian rural society which are more general than water-related factors. They can be described as general social characteristics of the rural communities within which Iranian ethnohydrology used to function. In the Iranian case, these non-water-related contexts that make coherent picture of the rural people's social life, include a short history of landlord-peasant relations and governmental rural policies at different times. Considering two mentioned stages of contextual analysis, water and non-water-related contexts of Qanat technology are both necessary for portraying an in-depth picture of the communities under my study. To sum up, the social level of a contextual analysis portrays general social life of particular groups of people who TEK systems function in their communities. I also use these two stages of contextual analysis to demonstrate the coherent picture of the local groups under my examination in literature review chapter of my research. To create an in-depth picture of their traditional water managements, I investigate water and non-water-related contexts of their communities.

In addition to the contextual analysis, an interpretive viewpoint in qualitative research examines the meanings which the people under study attribute to their practices. These meanings have been embedded in beliefs, myths and rituals. Interpretive analysis is based on the fact that human beings act toward things on the basis of the meanings that those things have for them. According to the interpretive approach, qualitative researchers have to see the world from the angle of the subjects they study (Flick, 2006: 66). It should be pointed out that interpretive analysis of qualitative approach that I intend to use is already included at the intellectual level of TEK; so, TEK studies are automatically interpretive because they try to interpret things "in terms of the meanings people bring to them" (Flick, 2006: 66). Through making use of the two capabilities of qualitative method, my research overcomes problems with current water management caused by the narrow focus on quantitative engineering discourse. Going deep inside the sociocultural contexts of a water management systems enables my research to indicate the dependency of water technology on sociocultural arrangements.

A quantitative approach cannot investigate water management as a sociocultural/moral phenomenon since it is not appropriate for exploring elements like social institutions and environmental conceptions in indigenous knowledge. For this reason, water researchers seldom intended to study the shift from the Qanat system to deep wells as a part of a social rural change in Iran. Traditional ecological knowledge is qualitative in nature, given that it includes moral and spiritual dimensions of a knowledge system opposed to (supposedly) value-free quantitative methods (Berkes, 1993). While quantitative methods have limitations when studying a large number of water management variables, qualitative methods can cover many more elements than just the technical system. So, by using context-sensitive explanations of water management, all four levels of the water management system can be explored. Putting the technology in the wider social context, qualitative methods can incorporate all the levels of TEK into mainstream quantitative and technical discourses of water management. Consequently, qualitative methods can contribute to best to my research.

Conclusion

In this chapter, I have provided a general overview of ecological anthropology, ethnoecology or TEK studies, and qualitative research, approaches around which I frame my project. Among all the methods in TEK studies, the four-level framework is the main analytical tool that can systematically integrate various layers of the Qanat system into a holistic paradigm. Also, I discussed critiques of these approaches and methods, because as I argued some criticisms have applicability to my questions and aims. The four-level framework and the contextual and interpretive analysis are among the major frameworks that I use to create a division between traditional and modern water paradigms.

In the following chapter, I examine local water systems in different parts of the world. Also, some conclusions arising from these cases will be stated at the end.

Chapter Three: Literature Review
Approaches to the traditional water systems across the globe

Chapter introduction

This chapter discusses the wider literature related to water systems across the globe. I try to understand the socio-technical transformations of the water paradigm in the non-Iranian cases within the context of modernisation processes. Also, the chapter covers a review of the writers' approach and methods. I do not strictly separate the four levels of these ethnohydrologies as I will do for the Qanat system in chapter four. It is noticeable that the cases of this chapter are divided into two sections. The first section includes a brief and comparative review of a few water systems. The second section presents a more comprehensive and in-depth analysis of three individual cases. The second group of cases is more similar to the Qanat system; accordingly, they need to be investigated in more detail. In section two, I explain the broader contexts of the water systems along with the technical-social-ritual aspects of these water systems. These contexts contain general characteristics of the local people's traditional and modern life. Each case results in some relevant conclusions towards the end. Eventually, a comparative discussion based on the all cases of both sections will be presented at the end of the chapter.

Introduction

A significant amount of research has been done on my wider topic, which is the evaluation of the technical and social practices of traditional water managements. A group of researchers has done case-studies (Ostrom, 2002; Toussaint, 2001), while others have cross-cultural tendencies (Strang, 2006; Trawick, 2001a, 2001b & 2008). Also, their geographical focus varies from Asia and Australia to Latin America. Environmental and social assessment of water systems is one of the main topics covered by the literature (Strang, 2009; Toussaint and others, 2001). Their assessment is a comparative evaluation which contrasts social and ecological impacts of traditional and Western-orientated water systems (Strang, 2009; 1997; Lansing). Regarding ecological effects of development projects, researchers believe that local systems are environmentally sustainable compared to the Western-orientated models

which have resulted in environmental degradation (Toussaint and others, 2001). In terms of social assessment, the studies indicate positive effects of socio-institutional aspects of local systems (Kelly, 1983). They argue that the traditional arrangements create collective managerial capabilities in the local communities (Ostrom, 2002). According to the literature, indigenous systems by a combination of rituals, social institutions and conservation practices develop a sense of water responsibility among community members (Toussaint and others, 2001). Also, indigenous models teach locals how to deal with water scarcity (Trawick, 2001). Conversely, modern arrangements neglect many socio-cultural aspects of water management, resulting in the underperformance of modern systems (Ibid). The researchers assert that the indigenous water systems have ecological and social advantages over government or market-based models. Ethnographic fieldwork (Toussaint and others, 2001; Strang, 2009 and 2006; Gelles, 2000, Lansing, 1981 and 1994) is an important method applied by many of the writers. Also, in reaction to the negligence about socio-cultural aspects in the present arrangements, the works put a crucial importance on these aspects of the water systems and their impact on water resources. In this way, the researches explore various contexts of water systems (Lansing, 1981 and 1994). Thus, it can be said that the reviewed works have a holistic nature (Toussaint and others, 2001; Lansing, 1991), a characteristic that makes their work closer to ethnoecology. Furthermore, criticism of modern water policies is another theme of the literature. Also, current patterns of water use and management have been portrayed as very unsustainable (Strang, 2009). The current arrangements of water management have been marginalising indigenous water users and their knowledge and management system (Strang, 2009; Gelles, 2000). Understanding the ideological divide regarding water is another concern of the reviewed works (Lansing, 1991; Strang, 2006 and 2009). This ideological conflict includes the clash between two groups of water users and their opposite values and practices regarding water. On one side, industrialisation and Westernisation is the dominant paradigm; on the opposite side, environmentally-friendly models of water management have been recognised. Furthermore, the process of transformations to a model of the state and market control of water resources has been one of the investigations made by the literature. This shift has taken place through external interventions by the state and market (Ostrom, 2002; Toussaint, 2001; Gelles, 2000). In addition, central decision-making as one of the main characteristics of this transformation has been highly criticised by the writers

(Ostrom, 2002). Finally, despite some differences among the writers' approaches, comparing modern and traditional, local and governmental and the subsequent tensions over water management are key debates and problems of the literature that this chapter reviews.

Section 1: A brief comparative review of the ethnohydrological systems across the world

Ostrom (2002), in her book "Improving Irrigation Governance and Management in Nepal", investigates the irrigation governance, management and performance in Nepal, a country dependent upon irrigated rice agriculture. Her research also examines current irrigation policies and their implementation in Nepal, the historical basis for modern irrigation development in the country, and finally evaluates recent policies for improving Nepalese irrigation performance. Australia is the focus of a range of social studies of water management. Fitzroy Valley Indigenous Cultural Values Study (2001) is a report by Sandy Toussaint, Patrick Sullivan, Sarah Yu, and Mervyn Mularty Jnr for the Water and Rivers Commission in Perth. In fact, its focus is the assessment of an indigenous water system among aborigines known as "the Dreaming". The Dreaming encompasses religious beliefs, practices and laws relevant to water resources. Similar to our project, the Fitzroy Valley report investigates different characteristics of Aboriginal knowledge about water and the impacts of this knowledge on the ecosystem and society and compares them to the environmental and social impacts of the large-scale irrigation projects. Strang (2009), a well-known writer in the field, in her book "Gardening the World" studies the major water using and managing groups' attitudes around water in the Australian State of Queensland. These groups include indigenous communities, farmers, industries, recreational and domestic water users, and environmental organisations. Also, this work examines these groups' different beliefs, values and practices regarding water. The writer studies water governance and the regulatory mechanisms through which this governance is enacted under circumstances that some marginal groups are losing access to water as powerful elites protect their own interests. Her work reveals conflicting ideologies concerning water use and management; in other words, the central ideological divide between different water-using groups in Australia.

Developmentalists who advocate growth, development, industrialisation and market economy are on one side of this fundamental divide. On the other side are conservationists representing an ecologically orientated viewpoint who regard the environmental costs of the current direction as unacceptable. Strang in "Uncommon Ground" (1997), again undertakes a comparison between indigenous and Western environmental beliefs. She considers how the human environmental relationship is constructed and why it differs from one culture to the next. The geographical focus is the Mitchell River watershed, on the western part of the Cape York Peninsula in Far North Queensland. This comparison takes place about two very different cultural groups in the region: the Aboriginal people and the white pastoralists on the cattle station who share the same land. It explores the cosmological beliefs of each group which inspires their different modes of engagement with the environment.

Another important group of relevant research includes those works with strong cross-cultural tendencies. Trawick (2001a, 2001b & 2008) has done comparative ethnographic research on rational irrigation systems in various regions of the world including Peru, Spain and Chile. "Water Rights and Empowerment" (2002) edited by Boelens and Hoogendam, another key source in the Andean irrigation literature**,** is a combination of technical and social scientific viewpoints that describe different regions of the Andes in Peru, Bolivia, Ecuador and Chile. Mabry (1996) undertakes a cross-cultural study of indigenous irrigation communities around the world. Funnell (1994) discusses farmer-managed irrigation schemes (FMIS). Coward (1997) evaluates irrigation management alternatives based on local management models across the world.

Many researchers examine similar questions about the water systems in their work. Social environmental evaluation of the two contradicted secular Western-orientated and local model of management is a common theme in the relevant literature. This kind of assessment also examines the positive results of spiritual meaning towards nature and water resources. Meanwhile, a set of questions is asked from more distant fields like political sociology, which include investigations about the relationships of a production system and political power (Lansing, 1980; Strang, 2006). In Ostrom's (2002) work, the task is to analyse and understand how institutions combine with physical and socioeconomic factors to produce irrigation systems in Nepal, how

governments can intervene at a local level without damaging the native institutions and how institutions together with physical and socioeconomic variables affect the irrigation systems. Meanwhile, Strang in "Uncommon Ground" (1997) asks why some patterns of values emphasise affective environmental concerns but some others do not. The study endeavours to sum up all the factors that encourage or discourages affective values about the community resources, and why some cultural forms create a long-term alienation from the environment.

Ethnographic fieldwork and holism are the theoretical frameworks and methodologies used by nearly all the writers. In the Fitzory Valley report, the research is generally fieldwork ethnography and the holistic approach is highly emphasised. The holistic nature of the study means that the report insists that beliefs, sentiments and practices about water cannot be treated separately; alternatively, they should be understood as a whole, known as "the Dreaming" (Toussaint and others, 2001). "Uncommon Ground", by collecting and analysing ethnographic data, carries out a comparative analysis of a range of cultural forms (Strang, 1997). Also, Strang applies long-term ethnographic fieldwork to two major Australian river catchments (the Mitchell River in Cape York, and the Brisbane River in southeast Queensland) in "Gardening the World" (Strang, 2009). Having used the aforementioned approaches, Strang's works can be called the ethnography of water; in other words, they are case studies that have been placed in the wider socio-economic and political context (Strang, 2006). Although the researchers mostly do not declare ethnoecology as their approach, because of their opposition to the reductionist positivist viewpoint about water management and also the strong holistic dimension of the works, they have many points in common with the ethnoecological approach.

In addition to the above-mentioned frameworks, some of the writers use more specific methods which differ case by case depending on the aims of their projects. Strang applies some key areas of anthropological theory concerning production and consumption and ethnographic analysis in "Gardening the World" (Strang, 2009). Participant method and open-ended ethnographic interviews are the methods used by Toussaint and her team to investigate a number of Fitzroy Valley communities (Toussaint and others, 2001). Ostrom implements Institutional Analysis and Development (IAD) in her study. This framework examines how the physical

biological world interacts with cultural settings and rules for managing the resources. The writer states that it is a suitable framework to combine the various disciplines to the study of common pool resources and common-property institutions. Also, how to obtain data on a large number of Common Pool Resources (CPRs) and how to organise a series of case studies across different regions of the world are further considerations of the author (Ostrom, 2002). To sum up, certain methods such as participant observation method, interview and in some cases political sociology are additional frameworks that have been used by some of the researchers.

Some researchers have as their goal a practical model of sustainable water management, while others carry out only theoretical investigations. Ostrom's (2002) book introduces a third avenue for human development predicated on community-based governance, different from governmental or privatised models of water management. Having investigated the self-organising and self-governing capacities of Nepalese farmers, Ostrom identifies the lessons that development practitioners can learn from the traditional Nepalese farmers' way of managing irrigation systems (Ostrom, 2002). Since there are some similarities among different geographical regions, some researchers make cross-cultural generalisations (Strang, 2006; Ostrom, 2002).

The reviewed works investigate functioning and structure of both local management systems and the opposite Western-oriented model and also the meanings and attitudes associated with these systems. Similar to other traditional systems, the ownership of the resources is communal in Aboriginal Australia. Aboriginal management systems are small-scale and holistic, comprising a set of beliefs that place human beings within nature alongside its other elements. Aboriginal lifestyle places few demands on the natural environment and non-traumatic changes to the landscape (Strang, 1997). Similarly in Nepal, each village had a farmer association which coordinated the farmers for water distribution and maintenance according to rules which suited the local situation. To summarise, these indigenous systems can be described as ritually-based, communal and holistic.

The transformation of water systems worldwide has led to severe disturbance of local systems of management. In fact, secular or so-called rational irrigation was a powerful

mean by which many "contemporary nation-states in the world extended their control over their peripheries" (Gelles 2000: 160). In the Nepalese case, policy analysts assumed that local users were unable to develop their own property-rights regime to use or manage natural resources in the mid-1980s. So, they recommended external agents to impose solutions for increasing efficiency. These solutions included the control of natural resources by a central government and later imposition of private property. In other words, the new model introduced the state and market control of natural resources management. An irrigation project in the Dang district of Nepal, the Chiregad Irrigation System, is one of the most important examples of this process. This system was built in the area previously irrigated by five irrigation systems managed by farmers. The existence of these traditional systems was not recognised by the Nepal Department of Irrigation (DOI). The DOI engineers designed the project without consulting the farmers in the area. Also, a water user committee was established by the DOI in a top-down method which meant that government irrigation officials became dominant in these committees and they just informed farmers about establishment of a water user committee without any attention to the pre-existing five farmer associations that had functioned for a long time (Ostrom, 2002). Damaging local adaptive mechanisms, ignoring indigenous models, the assumption of Western superiority, and central decision-making are among the common characteristics of these transformations across the world.

After dramatic changes imposed by a set of interventions, the current institutional arrangement of water management suffers from the same problems everywhere. In Nepal, thousands of farmer-governed irrigation systems have received just some small-scale support and have been the object of large and external interventions (Ostrom 2002). Tensions over water are rising in both the north and south of the state of Queensland in Australia. On one side are the agricultural, industrial, urban and domestic water users. Environmental groups who are becoming more critical of the ecological outcomes of rural and industrial water management constitute the other side of this conflict. Nevertheless, decision making remains closer to a 'growth is good' position which will cause particular kinds of land and water management practices along with their negative ecological impacts. As a result, water governance in Australia accords to a commodification vision in which water is a privatised economic asset. Modern farmers and graziers enjoy the social, economic and political

leadership from the colonial era. Also, industrial water users have a highly directive view towards environment. In the same way, the state government has focused on how to achieve security of supply through building large dams. Defenders of the intensive resource exploitation, commoditisation and privatisation of resources argue that this approach, rather than collective ownership, provides solutions to the water crisis. Their belief is in agreement with the principles of the Washington Consensus according to which competitive nation-states are abandoning natural resource protection and privatising their ecological commons (Strang, 2009). In the Mitchell River watershed of Far North Queensland too, the modern pastoralists are focused on the foreign (Western) elements they have imposed on the landscape. Their discourse is independent of the local conditions and landscape and has little to do with the ecological realities of the region, depending heavily on knowledge about the imposed European elements rather than local knowledge. They assess the land in quantitative terms as a totally alienable resource. The people on cattle stations receive education that has little relation to the local environment. The European settlers have been traditionally unaware to the limitations and pressures of the environment which caused a kind of intensive resource use. They believed that they must maximise the use of the land to create constant growth (Strang, 1997). Finally, one can identify that dominance of a Western-orientated paradigm, lack of consultation with locals and unawareness about local conditions, viewing indigenous population as backward, in some cases intervention of international economic forces, intense use of modern hydrologic technologies, and ideological tension among different water users as some common features of the present arrangements for water management.

Regarding environmental assessments of the water managements in different countries, the works mainly emphasise the sustainability of the traditional management systems and negative impacts of their modern counterparts in terms of physical and environmental impacts. The Fitzroy Valley Study (2001) indicates that some modern industries such as mining, modern irrigation, agriculture, and pastoralism have led to environmental degradation in Australia. Development projects and industries began to rise without consultation with indigenous owners of waters so environmental degradation processes was intensified: increased erosion, saltwater inundation, the waste of underground water, changes in river systems, etc. Among the most important projects which caused this environmental degradation, the report

mentions “the failed Camballin Irrigation Project” and the Argyle and Ord River Dams (Toussaint, 2001). Some other ecological effects of intense developmental activities are dryland salting and salination of subsurface waters as a result of extraction of water from underground aquifers. In Australia, current management arrangements for water have eradicated environmental values in many rivers. The Great Artesian Basin in north Queensland has suffered from a massive drop in the pressure and loss of springs. Finally, Strang believes the current patterns of land and water use in Australia are unsustainable and resulting in huge ecological damage (Strang, 2009). The above evaluations are clearly negative and highly critical about the physical/environmental effects of the modern water management.

The relevant literature about water systems in Asia, Australia and Latin America asserts the importance of the social constructs of water. The authors of this literature indicate that the sociocultural aspects have serious effects on how people manage their resources. Irrigation “is more than an act of hydraulic engineering” and “it requires institutional arrangements for the construction and maintenance of physical facilities” (Kelly, 1983). Ostrom, (2002) confirms the same results about Nepal. Despite the fact that institutional rules affect the capability of individual users to manage their water resources, most efforts in Nepal, like many other places, focus on the physical infrastructure which means that institutional aspects are ignored. Ostrom (2002) is convinced that the results of technological interventions in irrigation are disappointing. Lack of institutional arrangements for effective system management is above all the reason for the underperformance of the new irrigation system in Nepal. This is the same process that happened to other government-constructed systems of natural resources management; consequently, investments in physical infrastructure have led to the opposite result. A rich case study literature from disciplines such as anthropology, sociology, history, human ecology and agricultural economy illustrates self-organising and collective capabilities of native populations regarding Common Pool Resources (CPRs). Nevertheless, the beneficial local system called “five farmer organisations” has been severely weakened. Contrary to the newly established and non-functional water user committees, farmer-governed irrigation is more efficient and farmers can overcome local and collective action problems when they have sufficient autonomy. The reviewed research here asserts the capacity of resource users

to govern the resources, as well as the benefits of creating local organisations and selecting locals as leaders instead of government-managed systems.

The findings of the Fitzroy Valley Study of Aboriginal Australian water knowledge and practices indicate the same social assessment about the traditional water system. The research argues that indigenous people have water responsibility by a combination of rituals, conservation practices and social actions. However, development projects and industries arose without consultation with Indigenous owners of waters. Accordingly, modern industries like mining, irrigation, agriculture and pastoralism have brought many dramatic negative impacts. Some custodians transmit less knowledge of rituals to young people; hence the danger of water stories, activities and song-cycles disappearing is serious.

Trawick (2008) shows that the same system that emerged independently in many communities for sharing water under conditions of scarcity is an optimal one. He argues that these systems are highly effective and superior to several other kinds of systems today (Trawick, 2001). Also, he concludes that traditional systems are highly effective and sustainable ways of dealing with scarce water resources (Ibid). Others pointed out that despite the crucial importance of the sociocultural aspects of water management to Andean irrigation, these dimensions have been widely neglected during the past decades within projects developed by engineers who tend to prioritize technical aspects of irrigation (Boelens, R & Hoogendam, 2002). Meinzen-Dick and Raju (2002: 2) argue that a local management model has a comparative advantage over central government-based system because "the livelihood of local users depends on the resources". As can be seen, along with technical assessments of the water systems, the works cover more details of the sociocultural dimensions, such as water meaning, rituals and associated collective systems to manage water. These sociocultural assessments also include comparisons between traditional and modern institutional structures and mainly state the negative aspects of the modern systems.

Some researchers such as Lansing do not offer any practical recommendations. Nevertheless, the reviewed works mostly suggest solutions about how we can use traditional water knowledge for more sustainable water management. Moreover, a considerable part of the literature reveals that the cross-cultural lessons of these

evaluations are applicable to the contexts beyond the primary geographical focus of the studies. Strang (2009) in "Gardening the World" defends the conception of water as a common good and recommends an alternative and more holistic model of human-environmental interaction. Strang states that we need the conceptual and organisational models that may encourage more collective and sustainable interactions with water (Ibid). In another work, the writer advises finding what makes people act in an environmentally sustainable way. She reveals that what makes people value, in terms of their relationship with environment, is a cultural question (Starng, 1997). The Fitzroy Valley report (2001), in its 18 recommendations, puts forward very organised and practical suggestions. The report describes local and community-based water management via consultation and negotiation with indigenous people. Moreover, it suggests that further cross-cultural research would produce useful results for all water users, both Aboriginal or non-Aboriginal. While Trawick (2001 & 2008) recommends that traditional systems can contribute to local irrigation and even reforming water policy, he seeks the implications of local systems for both theory and policy. Generally speaking, Trawick, by the comparative studies of "hydraulic traditions", makes a few generalisations which are helpful for the current situation. Coward (1997) extracts some organisational principles from traditional water management systems: accountable leadership and mini-unit organisation. Nevertheless, he points out that these indigenous models are not equally applicable to all the irrigation projects being funded by the World Bank or other national and international agencies. As he mentions, indigenous principles of organisation are more applicable in small-scale irrigation systems, but it is possible to create some of the contextual properties of indigenous water management in the design of even large-scale irrigation systems. Ostrom (2002) advises some reforms such as reconsidering the assumptions upon which foreign assistance is designed. After the Second World War, a common supposition was that development must focus on state-building and large-scale governmental projects. Then in the 1980s, the focus was placed on market and private-sector alternatives to state-driven development. According to Ostrom (Ibid), donor agencies need to direct their efforts toward enhancing governing capacities of smaller communities rather than to replace the current infrastructure with modern and physically sophisticated technologies. To sum up the researchers' main recommendation, cultural solutions and institutional reforms more than technological investments should be taken into account for water management problems.

In the first section of the chapter, the results of the comparative assessment of local and modern water systems show that the community-based water systems are participatory and sustainable models of water use and management. They are eco-efficient and create communal water responsibility. Also, ethnohydrologies of the first part of the chapter include many perceptual and ritual aspects. These water meanings and rites have regulatory functions in terms of a community's relationship with its resources. Consequently, because of the importance of these socio-cultural dimensions, reviewed works investigate the broader contexts of water systems along with the techno-physical aspects of the systems. In fact, these holistic studies integrate practical and intellectual aspects of water management systems. Conversely, modern arrangements for water management have led to the dominance of a Western-oriented paradigm that views indigenous people as backward, does not consult with locals, and features the intervention of international economic agents and the heavy use of modern hydrologic technologies.

The next section of the chapter includes three studies with a case-based approach. In the second section cases, the contextual method of qualitative research has been applied at a deeper level. Accordingly, these studies collect a large amount of in-depth information about the social context of water systems in a way that enables the concrete social settings of the particular people who use a technology to be seen. In other words, the second group studies offer a comprehensive in-depth analysis by further context-related descriptions and also by investigating more information about the broader socio-cultural contexts of the water systems. Since these three studies are closer to my study of the Qanat system, I investigate them in more detail. Moreover, the Balinese case is discussed more extensively than the two other studies due to its importance and the more similarities which exist between it and the Qanat system. Although the cases in the second part are less comparative and more context-related, I connect them to the first section cases by presenting a comparative discussion at the end of the chapter. This discussion combines the conclusions of both groups.

Section 2: Comprehensive and in-depth analysis of three water systems

Lansing's Studies on the Balinese water system

The functions of Balinese water temples were unknown at the time when Lansing began his fieldwork on the "Green revolution". This revolution included a large technological transformation that spread across Asia in the 1970s. The Green Revolution involved replacing native rice with other varieties by use of chemical fertilizers. In the Balinese ethnographical literature, Lansing's books about different aspects of life in Bali including irrigation system are among the most important. "Priests and Programmers" (1981) is a widely cited book in which Lansing focuses on the conflict between advocates of the Green Revolution and the traditional water temple system. Lansing's (1994) book *The Balinese* is a case study in which the author comprehensively investigates the Balinese culture. Lansing's qualitative work on the Balinese case, as an ethnography and ethnohistory of the island, examines different contexts of the water temple system. The author investigates the traditional Balinese lifestyle as the social setting of water temples, which means his work has the contextual feature of a qualitative approach. Despite some ethnographies that have written Balinese history from foreign perspectives, Lansing's in-depth analysis in *The Balinese* investigates the ethnohistory of the island from a Balinese viewpoint which includes actors' subjective meanings.

The author takes a holistic position which means his research has some similarities to TEK studies. In fact, Lansing takes an Indigenous Knowledge perspective to compare the two rationalities of water temples on one side and the state and Western bureaucracies brought by development plans on the other side. He arrives at a theoretical understanding of water temples and comparative assessment of them with substitute modern agricultural structures. Like many other works, the author takes an ethnoecological viewpoint without declaring ethnoecology as his primary theoretical frame. Following his holistic approach, Lansing evaluates both "the social and ecological constructions of the water temples" (1991: 23). As another result of this holism, the author implements the "Ritual technology" concept of Georges Condominas as his starting-point and, like Condominas, challenges Eurocentric Western social theory. Lansing criticizes the distinction made by social scientists

between rituals and material technology in the case of traditional farming and irrigation in Bali. Seeing ritual as an integral element of technology, he explains the technical-ecological dimensions of water temples side by side with their socio-ritual aspects. Finally he asserts the fact that agriculture and irrigation are as much socio-cultural as they are technical. Lansing clearly indicates that the structural differentiation between technical practices and rituals/beliefs does not work, at least for traditional societies (1991: 135).

Regarding Lansing's theoretical/disciplinary approach, some more details are noticeable. Ethnographic fieldwork through conversations with farmers, temple priests and irrigation engineers are the main data-collecting methods used by Lansing in "Priests and Programmers". He also uses systems ecology modelling to analyse technical/ecological aspects of the temples. There are also some political and sociological considerations in Lansing's works. In "Priests and Programmers", he develops a group of questions which fall within political sociology. Through this set of questions, Lansing investigates the relationship of the control of irrigation and political power which is a long discussion about Marx and Witfogel. This feature of Lansing's research distinguishes his work from my project. In this regard, he evaluates the impacts of the temple irrigation on political power, the conflict of kingly power and the autonomy of the priests who were in charge of water management. He investigates who rules, based on who controls the productive system. From this aspect, the work examines how the autonomy of the irrigation system from kingly power results in a kind of independent power for priests. Considering different characteristics of Lansing's works on the Balinese traditional water management, his research can be described as studying Balinese ethnohydrology which evaluates both the social and ecological constructions of the water temples. In this chapter, I intend to draw a holistic picture of traditional water management in Bali along with its various contexts from the perspective of Lansing's works.

Traditional Water Management Structure in Bali

One can see the practical and religious aspects of rice production side by side with traditional Balinese water management. Subak, which is an association of farmers

sharing water from a single source like an irrigation canal, have both agricultural and religious-ritual functions about water management and rice cultivation. A Subak head has to organise both of the aforementioned activities for the members: these activities include rituals of the "rice cult", which are carried out in the fields and temples, and also physical works that include field preparation and harvest. According to Geertz's model of the relationship between the two tasks of a Subak, the timing of the ceremonies leads to firm and explicit rhythm of the cultivation. For example, the "water-opening ceremony" marks the beginning of the irrigation schedule, just as the harvest ceremony indicates its end. Geertz demonstrates that the rituals of the rice cult provide a way for the farmers to time the flow of water and the phases of agricultural labour. Other anthropologists have argued that the real picture is more complex and the match between rituals and rice growth is not that simple. The Subak head who Lansing was working with believed that Subak rituals have more important functions than just timekeeping.

One of the Balinese temples, the Temple of the Crater Lake, can be used as a key example to understand the water temple system. The temple is always manned by a small staff of priests and elders who are available to welcome Subaks experiencing problems with water shortage. Meanwhile, the temple kitchens are an ideal place for Subaks to handle problems and disputes. The temple kitchens as mentioned earlier are managed on a regular schedule by teams of priests and elders. The permanent priests are chosen in childhood as lifelong servants of the goddess. This priesthood is organised in a hierarchy and at its summit is a single high priest, Jero Gde, believed to be the earthy representative of the goddess of the Lake. He offers sacrifices to the goddess on behalf of the hundreds of Subaks that make up the temple's principal congregation and by night he may receive guidance from her in dreams. His relationship to the Goddess of the Lake gives him a special authority over irrigation water; the Goddess believed to give water to her Subaks. The Subaks also acknowledge the Jero Gde's right to decide upon water allocations, in the name of the Goddess. His authority is recognised by Subaks for settling the disputes over water issues. Jero Gde, the high priest, is asked for more water and he should make a decision about these demands. According to some Subak heads who believe the temples are the centre and the origins of waters, the Jero Gde has the authority over the allocation of water rights.

The largest water temple in the village of Sukawati is another example of the practical role of water temples. The Pura Er Jeruk temple congregation includes all farmers of the village. Fourteen smaller temples are below the largest temple. The Subaks meet at the Pura Er Jeruk temple to discuss planting seasons, and then they fix their planting dates which means allocating planting time to Subaks. During the dry season, a rotational system operates in which every group receives water once every five days. By setting the cropping pattern and irrigation schedule, the Pura Er Jeruk temple attempts to optimize water sharing, while establishing a widespread fallow period to reduce pest infestations.

The relationship of water temple rituals and the practical ecology of the rice terraces is a symbolic logic. In discussing the ritual's impact on the real world, Lansing points out that ritual system is not just a gloss on the productive relationships. In fact, true eco-friendly technical practices, not in isolation but along with social relationships of water temples, can maintain sustainability within the ecosystem (1991: 120). According to cosmological beliefs about water temples, the Goddess of the lake brings life to the fields and the villages by causing the rivers and springs to flow. So, wherever farmers divert some of the waters of Goddess into their fields, they construct a temple to show their gratitude with prayers and offerings. The temples also provide a place for farmers to meet and discuss practical problems, such as irrigation schedules. Chains of water temples articulate the hydro-logic of each irrigation system. Temples and shrines are situated in such a way as to exert influence over each of the major physical components of the terrace ecosystems, including lakes, springs, rivers, major canals, blocks of irrigated terrace, Subaks, and individual fields. The temples link physical features of the landscape to social units according to particular production logic: the congregation of each temple consists of the farmers who obtain water from the irrigation system controlled by the temple's god. Each farmer has a small shrine at the spot where irrigation water first enters his fields. Upstream from the farmer's field shrine, the next water temple is the Subak temple, representing a block of irrigated terraces with a common water source. Each spring, lake, and headwaters of each river have shrines or temples. The largest water temple is farthest upstream: the Temple of the Crater Lake. Based on a symbolic spatial contrast, upstream and downstream temples have very different functions. Upstream

water is associated with the life-giving effects of water, regarded as a gift from the Goddess of the lake. In contrast, downstream water is used to wash away pollution.

To conclude this discussion of characteristics of the traditional water system in Bali, it can be seen that water management, similar to other crucial aspects of the life in Bali such as marriage and death, is a ritually regulated task. Consequently, temple ceremonies are important and highly respected to Balinese people as they devote part of their resources to these rituals. In the Balinese model, the balance between individual interests and communal work has been developed through a network of the temples and Subaks. Subak comprises the social system associated with the water temples. Subaks, as cooperative farming units, are comparable with Bonehs in Iran. Subaks include units of farmers who share water from a single source. In fact, they include agricultural units that have various ritual and physical functions. Ceremonial and agricultural functions of the Subak system indicate an obvious integration between techno-physical and ritual aspects of water management. Furthermore, Balinese temples as religious-ritual institutions also provide managerial and organisational services for water problems. Balinese temples deal with water shortages and settle water disputes among Subaks. This water dispute resolution works through hierarchal authority of the temples and priests.

The ecological crisis that resulted from the Green Revolution and a new water management regime

The primary impact of the Green Revolution on the traditional irrigation system was putting an end to the practical role of the temples in the creation of cropping patterns. The development planners considered the water temples as religious institutions which have no productive role to rice production. The Indonesian government as a supporter of the Green Revolution promised to increase rice production and regarded the end of the role of water temples as an inevitable result of technical progress. Government planners were eager to find new ways to increase agricultural yields. But in Bali, this immediate increase in rice yields by removing water temples from irrigation management and their cooperative arrangements soon resulted in water shortage. In addition, to improve the Balinese irrigation system, a major irrigation

engineering project was launched in 1979 by the Asian Development Bank. By intervention in 130 Subaks, the Subaks lost some of their traditional functions and their authority as well. The Subak improvement schemes were to bring rice cropping for as many Subaks as possible. These measures led to the abandonment of the Balinese cropping calendar and also the new programme began to remove the temples from control of irrigation and cropping patterns. While religious rituals continued in the temples, field rituals no longer matched the actual stage of rice growth. So during the dry season, the supply of irrigation water became unpredictable and agricultural offices began to report chaos in the water sharing. Farmers were planting without a coordinated schedule and the farmers/Subaks ceased the centuries-old cyclical cropping patterns.

In 1979, the farmers have decided that the new policy of continuous rice cropping had failed since it made the water supply too unpredictable but policy makers were still pushing the Green Revolution, so there was a political struggle going on between farmers who preferred to return to the old irrigation system by temples, and those who wanted to grow rice as often as possible. By the mid-1980s, despite the cash profits from the new programmes, many farmers were pressing for return to irrigation scheduling by the water temples, but to foreign consultants at the Bali Irrigation Project, the proposal to return control of irrigation to water temples was interpreted as religious conservatism and resistance to change. In contrast, the Balinese temple priests and farmers argued that the water temples were necessary to coordinate cropping patterns, so that there would be enough irrigation water for everyone. Development specialists were not eager to hear at first, but with the passing of time the final evaluations confirmed that the substitution of the high technology and bureaucratic solution was counter-productive, and this was the major factor behind cropped areas declines between 1982 and 1985. Erosion of the traditional system threatens the long term sustainability of the irrigation system. Also, the later reports revealed that no modern project in Bali exhibits the self-sustained high performance of the previous local system. Having realised the high cost of the lack of appreciation of the traditional regime, officials also suggested that it is beneficial seeking advice from locals engaged with water issues, since it can bring the two parallel water management institutions into closer contact. Thus, for the first time (after the Green Revolution), the water temples have achieved recognition by the state irrigation

bureaucracy which had assumed that agriculture and irrigation are purely technical processes and farmers should plant as often as possible.

Conclusions of the Balinese Case

Lansing's works on Bali include in-depth and contextual researches, while it includes the local people's subjective viewpoints. As can be seen from one of the titles "Priests and Programmers", the writer focuses on the contest between the traditional and modern systems of irrigation in Bali. His works are not just evaluations of water management variables in isolation, but also comprise a review of the contexts of traditional and modern water management and the various levels of each technology. In my words, he assesses the non-water-related contexts of the traditional temples system along with the water system itself. Thus, Lansing's works are the complete demonstration of the contextual characteristic of qualitative research. The main neglected point in Lansing's work is the probable deficiencies of the traditional system under his study, such as hierarchal inequalities and farmers' dissatisfaction in Bali which might have created the need for a water paradigm change in the twentieth century.

Water management and irrigation like other social phenomena in the Balinese lifestyle required performing certain rituals. This ritual aspect of the Balinese ethnohydrology includes a system of water temples together with the agricultural units of Subak. The primary ecological role of water temples was to preserve social relationships among productive units through a system of social coordination. The water temple scale of cooperation produced the best harvests by finding the right balance between water sharing and pest control; so, the water temples were playing a vital role in the ecology of the terraces. Some rice terraces in Bali are a thousand years old and have produced one or two crops per year for many centuries. Rice terraces are the most ecologically stable agricultural system capable of supporting a large population indefinitely. The temple network leads to improvements in sustainability and the ability to cope well with changes in the environment. This network is a social response to the problem of sustaining the rice terraces. Within this

system, all the farmers sharing from the same source must cooperate in construction, maintenance, water allocation, and the management of disputes.

The Green Revolution in the absence of the ritual management put an end to a "hydraulic solidarity". The structure of water temple network has been developed through a process of trial-and-error adaption by the farmers. On the contrary,Western-oriented international players; unaware of the local conditions, introduced uncoordinated individual arrangements through a system of deliberate planning by royal engineers or other planners. While in the time before the Green Revolution the temples had set an irrigation schedule for the fields in their vicinity, with the new policy of continuous rice cropping the temple had lost the control of irrigation schedule. Accordingly, everyone was trying to grow rice as quickly as possible. This change soon caused water shortage and outbreak of rice pests and diseases (Lansing, 1991). Similar to the abandonment of the Boneh system in Iran, the process of losing the temple/Subak functions soon resulted in collapse of the cooperative arrangements. At last, chaos and water shortages were the ultimate consequences of neglecting the traditional system of water sharing in Bali. In the conclusion of the modernisation process in the Balinese agriculture, the Green Revolution can be described as the Balinese equivalent of Iran's White Revolution. This transformation shaped the same reductionist assumptions of the White Revolution towards agriculture, irrigation, and water management. Within this revolution water temples were regarded as disposable aspects of the water system. This means that modern development planners thought that the water temple system is useless. The main emphasis of the Green Revolution was on increased production, while removing the water temple/Subak system was assumed as the prerequisite for development and technological progress. Despite development planning, many reports later revealed that no modern alternative could perform the function of the old system of the temple/Subak. This recognition of the value of the traditional model and farmers' interest in return to the old system is maybe the main difference of the Balinese and the Iranian case. Meanwhile, the Balinese locals were insisting on reusing the traditional collective system after a short period. In the Iranian case a lack of farmers' interest in group work was clear. Finally, traditional water management in Bali is capable of doing a better job of management than either uncoordinated planting (the Green Revolution system of "every man for

himself") or centralised governmental control, each of which are partly responsible for recent water mismanagement in Bali.

The case of Stour Valley in England

Strang (2006), a well-known writer in the field, in *The Meaning of Water*, compares the ecological/social functions of a traditional and modern model of water meaning, management and ownership. The geographical focus is the Stour Valley, Dorset county of England. Her research explores the controversies over water policy and management in complex political environments**.** By investigating the meaning of water for both providers and consumers, she explains the conflict between private ownership and management of water on the one hand and conservation of water resources on the other. Her work reveals conflicting ideologies regarding water use and management; in other words, the central ideological divides between different water-using groups in the geographical area under examination. Feminism, theology, archaeology and psychology are among the disciplinary approaches considered and applied by Strang. In addition, the author (as does Lansing) draws attention to some political and sociological considerations about ties between resource control and power structure; in other words, the relationships of law, power and ownership of productive systems (Strang, 2006). Moreover, ethnographic research, cultural mapping, local archives, folklore, long-term fieldwork and in-depth interviews are the methods which have been used by Strang in *The Meaning of Water*. In fact, Strang's work is an ethnography of water, a case study approach placed in the wider socio-economic and political context (Strang, 2006). As a result of investigating these wider contexts, her research automatically benefits from contextual methods of qualitative research. Furthermore, the writer focuses on the intellectual level (fourth level) of the water paradigm which here is water meanings as the most subjective dimension of a water system. Therefore, her work can be described as both contextual and interpretive.

Social and environmental evaluations of the two opposing Western-orientated and local models of management are the main objectives in Strang's work. She also

investigates the relationships of production system and political power. On the other hand, other sets of questions examine the positive results of spiritual meaning towards water resources. The writer comparatively evaluates the ecological and social consequences of changes in water management along with tracing the influences of water meaning upon patterns of water use. In this regard, the author's main concern is how water meanings affect water use and water policies. The diverse meanings and values attached to water by the residents of the Stour Valley in England include the emic and social dimensions of traditional water knowledge in that area. The writer intends to find which sacred meaning of water in the past by the Stour Valley locals helped maintaining a balance between human demand and water resources capacities. Strang reveals why some traditional patterns of values emphasise affective environmental concerns but some Western-orientated methods create a long-term alienation from the environment. Concerning Strang's aims, she seeks a model of local/cooperative and ecologically less destructive water management and ownership model, a model that is in agreement with the cultural meaning of water in the past. To resume, after understanding the beneficial ecological and social functions of traditional water management, Strang recommends a sustainable way for water management. It should be mentioned Strang is aware that these lessons cannot be directly implemented in a modern context due to the difficulties and complexities of applying TEK in a modern context. This is the same point according which the co-management framework does not intend to replace modern management with traditional methods. In brief, Strang is going to show after realising the positive ecological and social impacts of traditional water knowledge in the Stour Valley, what lessons we can learn and how we can use them for a collective and more eco-efficient local water management.

The writer clearly declares that she intends to contextualise the meaning of water.
In agreement with the contextual approach of qualitative method, Strang insists that interactions with water take place within a landscape which is the product of specific social, spatial and political arrangements along with cosmological and ritual-religious beliefs, as well as ecological constrains (p: 5). This can reflect my concept of non-water-related contexts of water management which Strang investigated too. The writer's geographical focus is the Stour Valley located in an affluent southern English county called Dorset. Historically, Dorset has been a rich farming region, dominated

for several centuries by major landowners. In the past, the rural population remained relatively stable, with one generation after another taking over farm tenancies and the range of small domestic businesses that were essential to the local economy. The farms that used to maintain social stability have experienced the process of becoming large commercial enterprises that conduct their activities in relative isolation. Like many other areas in the UK, Dorset experienced some transformations in the twentieth century. The economic focus of the county has passed from agriculture into a dependence on urban services through a manufacturing phase. Consequently, at present, a quarter of employment is in manufacturing or construction, and a similar proportion in tourist-related industries. Over 30% of jobs are in public administration, education, and over 10% in banking or financial services.

The population is heavily concentrated along the coast while there has been an influx of retirees from London to the northern parts of the county in the past 20 years. Meanwhile the population is growing, and – with smaller households - new housing is increasing more quickly. In Dorset's rural communities, even 50 years ago, the inhabitants knew most of the people in the vicinity. The shift from relatively stable social organisation to transient settlements has brought an arrival of strangers. People move home more frequently and also move between urban and rural areas much more freely. As a result of these transformations, even in the most stable rural areas, people feel a loss of collectivity. They are surrounded by others whose beliefs and values may be widely different. Their fragmented landscape is under siege by strangers who want access without responsibility. Nevertheless, some aspects of village life still produce a sense of community. The Church provides some continuity, mainly for the older generations. Village pubs and clubs create a secular social space. Some locals have become active in village events, such as local history groups, conservation activities and recreational projects. The Stour Valley is experiencing a range of problems with industrial, farming and domestic wastes. This means that like the rest of the UK, Dorset's environment is under considerable pressure (p: 10). In this way, the landscape is controlled by private industries and government agencies whose local involvement has decreased because of centralised model of management. These national, international, and in brief non-local players are not familiar with the local conditions and do not have the sense of communal responsibility about the landscape

and its resources, water included. These arrangements can facilitate the same pattern of the water paradigm shift in Iran.

Strang explains some details about functioning and structure of the local management system in the Stour Valley and the opposite centralised model; in addition, the attitudes behind every system are covered in her work. Dorset's landholding and farming patterns originates from Celtic and Roman economic activities and Saxon yeoman farming system. Later, this ancient water system merges with the modern system of water treatment and delivery, industrial farming and urban development. The wealth of the Stour Valley improved with the introduction of water meadows in the seventeenth century. This system includes carefully managed artificial channels.
Within the old system, village communities maintained direct involvement in water management and the traditional farming pattern placed little pressure on water resources (p: 25). The system of water meadows required considerable cooperation that was achievable in relatively stable communities. Traditional Water management was localised and community-based in the region. Strang correctly points out the similarities of her case with the spacio-religious ties of the Balinese case on which temple/Subak system has been relying for a long time. The old system of the Stour Valley linked people not only physically but also in social terms. Finally, collective management of the physical landscape created a sense of community. Strang's evaluation of the external effects of traditional water meanings and values indicates that these cultural constructs are influential over every decision about water. These social structures served to make water users involved in resource management and collective responsibility; so, they have ecologically sustainable impacts in technical terms.

In contrast to localised water management, a new paradigm of delocalisation and centralisation created by national, international and private agencies deny the reality of local human environmental relationships. Defenders of the intensive resource exploitation, commoditisation and privatisation of resources argue that this rather than collective ownership provides solutions to the water crisis. Their belief is in agreement with the principles of the Washington Consensus according to which competitive nation-states are abandoning natural resource protection and privatising their ecological commons. But despite the above group, intensifying resource use in

Stour Valley resulted from the Industrial revolution has disturbed the local aquatic systems. Most water supplies were no longer situated within communities in which local social and economic relationships contextualised. In this way, water resources became subject to negotiations between State and industry. Control over water was abstracted from small communities and shifted to urban communities and semi-local water supply companies. Then the privatisation of water returned it to the control of small elites which was very different from the old feudal ownership. More than a decade after the water utilities were privatised in the region, people describe this change as "the worst thing they ever did" (2006: 3). Moreover, the writer points out that industrial water users have a highly directive view towards environment. Despite the efforts made by environmentalists and water managers, water users have become unwilling to save water. In the UK, more than half the years in the last decade have been drought years with insufficient water levels in some areas. A combination of reduced water levels and increased waste production has led to reproductive and health problems (2006: 1). None of the above policies has succeeded in decreasing water use (2006: 45). Lastly, the water governance in Strang's case is in accord with a co-modification vision within which water is regarded as a privatised economic asset. Accordingly, decision making remains closer to a 'growth is good' position which will cause particular kinds of land and water management practices along with their negative ecological impacts.

As a result of the above mentioned discourse of commodification and centralisation, the control over water resources has shifted to a non-holistic approach through indifferent bureaucracy. This has led to the perceptual disconnectedness and alienation between water users and their resources. A reductionist materialistic view of water replaced some myths and scared meanings associated with water. This process happened through a paradigm within which nature is perceived as separate from human culture and civilisation (p: 115). After this process, individual interactions with water have become increasingly indirect. This means water management became very separate from everyday lives of water users. As a result, the ecological effects of water usage and management are perceptually and physically distant from decision-makers. In brief, the social impact of the modern management in Stour Valley is that the water stakeholders have neither physical nor social "common ground". In addition, by exporting the capitalist ideology to the developing

world the same problems of the UK water industry are being created everywhere. Strang describes this situation as cumulative environmental degradation. Finally, the water management modernisation in the case of Stour Valley includes a shift from collective ownership and management to a model within which the wider population has become a passive recipient in water management. Strang concludes that as long as the policies and practices cohere with the traditional water meanings they can engender more careful water use; accordingly, the modern paradigm which is at odds with the local-based water values mostly develops unsustainable water usage and management patterns.

Concerning Strang's recommendations, she seeks a model of local/cooperative and ecologically less destructive water management and ownership model. Also, her work has strong cross-regional/cultural aspects. As said by the writer, the traditional meanings toward water are cross-cultural and can be seen in every part of the world. Also because of people's unhappiness about their loss of collective control on water in many other regions, the lessons of the Stour Valley would be welcome in other countries. The author tends to make a generalisation based on her ethnographic research. Strang defends the conception of water as a common good and recommends an alternative and more holitistic model of human-environmental interaction. As mentioned by Strang, we need the conceptual and organisational models that may encourage more collective and sustainable interactions with water. People still draw images of past communities and systems of management to formulate an ideal model of water use and management. Because of this reason, the model of "truly collective ownership of the land and other resources" (p: 247) can be found in Dorset's past.
The writer advises to find out the answer of this cultural question that what makes people care to act in an environmentally sustainable way, instead of concentration on the techno-physical solutions.

In conclusion, "The Meaning of Water" examines the major water using and managing groups' attitudes around water in the Stour Valley of Dorset County. Strang undertakes a comparative evaluation between the ecological/social functions of two contradicted systems. First, the traditional model of water meaning, management and ownership implemented by Victorian philanthropists and local communities in the past and second, the modern counterparts of the above practices and meanings. The

book brings to attention a fundamental divide between developmentalists offering growth and development, industrialisation and market economy and conservationists representing an ecologically oriented viewpoint who regard the environmental costs of the current direction unacceptable. By comparing different beliefs, values and practices of two differing water paradigms, it is concluded that most environmental problems are created by social and cultural choices; so, use of technical solutions are not adequate. The central thesis here is that human environmental interactions are an expression of cultural values which the author calls it "particular mode of interaction with the environment" (p: 5). Finally, the water management model in the UK which is being exported elsewhere is extremely problematic, since it actively encourages high level of usage and an unwillingness to act cooperatively. This dominant institutional structure leads to social tensions over water and environmental degradation under circumstances that some marginal groups are losing access to water as powerful elites protect their own interests.

A traditional irrigation system in a highland community of Peru

"Water and Power in Highland Peru" (Gelles, 2000) focuses on the state and local models of irrigation in the highland community of Cabanaconde where irrigation land is a primary source of wealth in the community (Ibid: 13). The main theme is the conflict between two logics: the imposed logic of foreign actors by support of Peruvian government and the local one which is a ritualized irrigation. The book explores different layers of meaning and also cosmological foundations of irrigation found in state and local water distribution models. The research can be described as a case study of resistance to Peru's governmental development. The writer understands Andean irrigation in terms of the way that larger regional, national, and international forces enter the community and also in terms of cultural divide in the contemporary Peruvian society. It demonstrates that the clash between local/ritualised model of water irrigation and the secular state model is widespread in many Andean communities while local communities refuse to allow the state to determine local irrigation practices. Gelles asks how do development organisations and the governmental Peruvian bureaucracies interface with the local irrigation units? What is the political and cultural nature of this interface? The writer uses a contextualising

analysis of Clifford Geertz according to which irrigation systems along with ritual, myths are "texts to be read". As the writer mentions, on contrary to this integrative view, most anthropological studies of irrigation and applied research have taken a positivist approach coming from natural sciences. Again, this non-holistic approach divorces the relationship between society and technology from cultural-historical circumstances. Also, Gelles argues that an objectivist bias continues to guide the research on irrigation and other common property resources management. Participant observation, informal interviews, engagement in the community's lifestyle are used by Gelles. The study aims to contribute to realising the productive potential of those traditional infrastructures which have been neglected because of various reasons including the negative stereotypes of highland people in Peru.

The general context of the highland community of Cabanaconde contains region's colonial history and contemporary Peruvian system of stratification. Throughout the colonial period and still today, Cabanaconde has remained ethnically distinct from other communities in the Colca Valley (p: 26 and 27). The productive potentiality of Cabanaconde valley led to the Andean empire of Wari and Inka, to colonise the community and its hydrological system. So, this part of the Colca Valley was politically and economically important by that time. Intensification of agriculture allowed for greater population density. Cabanaconde has had a greater concentration of Spanish residents than other communities. Later in the nineteenth century, England and the United States increasingly came to replace Spain in the regional economy. The large concentration of Spaniards in Cabanaconde has greatly influenced its ethnic dynamics, in the way that a small group of Spanish families of Cabanaconde retained power through a separate identity from majority of indigenous population. This means that the ties of whiteness and power are strong in Cabanaconde. Meanwhile, highland communities, making up the biggest productive agropastoral units, are iconic of indigenous culture and according to many stereotypes they are backward and unproductive. Accordingly, it can be said that indigenous people are denied opportunities in Peru; thus, many people prefer to abandon their cultural and ethnic identity to get greater prosperity (P: 45). In fact, many indigenous Cabanenos intend to free their children from peasant status by becoming professionals with steady salaries. This desire requires the individual to deny his or her highland roots. This process reproduces marginalisation and stigmatisation of Andean culture and identity.

This pattern hugely influences state and regional politics of irrigation since agricultural activities and cultural identity intersect in Andean community. In Peru today, a dominant Western-oriented minority deploys its worldview throughout the provinces by means of educational system, language and also its water policies and irrigation bureaucracies. In fact, this dominant group is a coastal society with Spanish descent people and is located at the centre of the Peruvian nation-building.

The Andean cultural logics tied to water and mountains create a strong bond between the territory and a dependant social group. Like other indigenous people of the Andes, Cabanaconde people also often traces their origins to sacred mountains, lakes, springs, and rivers. The ocean which is regarded as the "mother lake" together with lakes and rivers form a hydraulic network through which the human world originated. Regarding the case of Cabanaconde, there are spiritual connections which bond the town to Mount Hualca-Hualca and other deities in the surrounding landscape. So; these protector spirits of communal identity must be regularly honoured with ritual offerings and religious celebrations. After the Spanish conquest, the Spaniards attempted to destroy the native belief system of the people they conquered. There was both accommodation and resistance inside the local communities. In some cases, pre-Colombian ethnic identity linking local deities, territories, and peoples were reconfigured through Iberian beliefs and practices. At the moment, the great majority of the residents economically rely on agricultural and pastoral activities. Politically, the contemporary official structure of Cabanaconde, like many other highland communities in Peru, includes the municipal council, the governor, the peasant community, and an Irrigators Commission. But Cabanaconde's official recognition as a Peasant Community in 1979 ended the domination of some of local elites. Today, the most democratic institution in communal life is the Peasant Community which as a corporate body defends communal interests from the internal and external threats (p: 35). To summarise, Cabanaconde's history shows that communal institutions of the town have always been joined to larger political and economic forces and the colonial context.

The traditional water system

Native Andean religious beliefs and rituals have always been a fundamental component of local systems of agriculture; in particular, water is the centre of much religious and ritual thought and practice. Cabanenos have a vast knowledge of water flow, subterranean filtration, canal and terrace construction. Their technical knowledge is combined with religious ideas about rituals of assuring fertility and abundance of water. This set of elements constitutes a system of traditional knowledge which has been named "Andean ethnohydrology" (p: 55). As mountains, water and the earth have been at the centre of indigenous people's religious systems throughout Americas (p: 157), the local water paradigm in Cabanaconde is also highly ritualised and regards water as part of a larger social and symbolic universe. This local indigenous model of irrigation has its own communicative rationality when it comes to water rituals. Irrigation water is a ritually elaborated resource in Andean society which covers longstanding ritual, agricultural, and hydrological formation. The irrigation rituals performed by water mayors is one the most important part of Cabanaconde's annual cycle of rituals. In the ritual competition among water mayors, their social and spiritual selves are publicly displayed and the entire community observes and participates in the ritual level. An example of water ritual celebration is Water fiesta, the physical cleaning and spiritual blessing of an irrigation system which is common among hundreds of Andean communities.

In terms of institutional arrangement, it has been said that irrigation water in Cabanaconde is a form of common property. Within this traditional model, water is controlled by a community of interdependent users and outsiders are usually excluded. The purpose of this mayor system is to assure communal control of distribution and continued fertility of the fields. Irrigation is an important arena of social interaction which structures the private and collective calendars of Cabanaconde people during much of the year. Individuals' access to Irrigation water, as a common property, is managed by a village-wide association of water users which is the Irrigators Commission. Also, Cabaneno irrigation rituals are performed by the water mayors and irrigators during the distribution cycle which includes four rounds of water. The water mayors who carry out important rituals are in charge of water distribution during the yearly irrigation cycle. Finally, it can be seen that the

traditional system of water mayors and local irrigation model plus many terraces and water canals which were build by indigenous states are fundamentally different from the state model.

Transition process

The beliefs and practices of indigenous Andeans in Peru, Ecuador and Bolivia are largely ignored by the dominant policy-making and cultural discourses. Instead, water availability is mediated by national and international political and economic forces. Following the Spanish invasion, thousands of irrigation canals were abandoned but the growing population has made attempts to recover some of the lost infrastructure. But again, state officials in Peru and some other Latin American nations ignored indigenous resource management as a result of the alleged superiority of modern Western culture. The great state intervention in irrigation practices of highland communities broke the power of local elites, power that already was being challenged from within communities in the 1960s and 1970s. State officials attempted to rationalise water management by instituting new government-based structures. The state sponsored irrigators' commission promoted a new form of water management which challenges the cultural orientations of the local model. On the other hand, local elites and state officials attempted to eliminate local model of water management during the recent decades. The Western-oriented model was diffused through development programmes that extend state control of national and international power-holders, while the government sidelined the effective indigenous models of water distribution. In fact, the secular state model of water management was inspired by modernisation theory and by national power-holders and decision makers who live in coastal cities with Western lifestyle. The Peruvian regime imposed modern bureaucracy and the norms that challenged longstanding non-Western cultural frameworks for water management.

To compare the efficiency of two systems, one can observe that the ritual logic which secures an abundance of water is fundamentally in opposition to the secular model of the state which has a bureaucratic approach towards water management (p: 71). The traditional system has a fixed sequence of distribution not found in the state model.

The state officials failed to understand the local model's cultural rationale and the way that the local model effectively classifies and distributes water. The state's bureaucratic model ignores the Andean cultural orientations and reproduces the cultural hegemony of the dominant Western-oriented culture (p: 152). Despite all the changes by the state, many people believe that the state model is less efficient and less equitable (p: 151). It seems that traditional system of water mayors makes water mayors more conscientious and fair in water distribution. The system of water mayors is underwritten by the indigenous logics about efficiency and availability of water. Given the mentioned facts, highland peasants regularly apply cultural resistance to defend their control over irrigation water. Andean peasants often resist the new water bureaucracy since it creates a cultural hegemony by a nation-state which doesn't respect the highland cultural values. As a part of the resistance against "state-sponsored cultural imports", Cabanaconde continued using the local irrigation model and recovered abandoned infrastructure. The same struggle is taking place in hundreds of highland communities in Andean region. While, ideologies of national development throughout the Latin America which assume that indigenous people must renounce their ethnic identity, many indigenous people today continue to use the extensive farming systems and infrastructures which have been established by the Pre-Columbian empires in the Andean nations of Bolivia, Ecuador, Guatemala, and Mexico.

In brief, "Water and Power in Highland Peru" is an assessment of water management arrangements in an Andean highland community through pre-Colombian, colonial and contemporary times. From a wide perspective, the ongoing clash between local and state water management model originates from a racist colonial legacy in the Peruvian society within which indigenous people have been regarded as racially and culturally inferior. The theoretical assumptions underlying the colonial legacy include modernisation theory and viewpoints that regard non-Western others as static (Gelles, 2000: 160). This kind of worldview has found its way into irrigation development plans and state bureaucracies by promoting supposedly universal valid formulas without attention to the local contexts (Gelles, 2000: 160). Issues of local autonomy and different cultural understandings of irrigation water are at the heart of the conflict between state and local water paradigms. While political forces at the national and international level try to condition Cabanaconde's relationship with its resources, the

religious, ritual and cosmological concepts are used by Cabanaconde people against the state model. These beliefs and rituals around irrigation are parts of a larger cosmology regarding mountain, water, and the earth deities which extends to agricultural activities as well. Assuring fertility, health and prosperity are the purposes of the agricultural and irrigation rituals in Cabanaconde. The author appreciates the spiritual, social and emotional centrality of water in the Andes because ritualised communal work involves the entire community, the kind of engagement that increases water availability for irrigation. Moreover, the findings from this study can be applied in other culturally plural countries in terms of community, irrigation and common property. Also, the writer connects the irrigation modernisation in Peru with the Balinese case, given the fact that in both cases local models of irrigation are challenged by Western-orientated state models. These similarities with the Balinese case reveal a large process in which non-Western areas have been organised into, and transformed according to European constructs (Gelles, 2000: 159). The writer concludes that the indigenous groups in Latin America can adopt new technologies without necessarily having to sacrifice their old ritualised water management that has been profoundly joined into the local identity.

Comparative Discussion

To combine the results of both sections of this chapter, it can be said that after the dramatic changes which have been imposed by a set of state interventions, the current institutional arrangement of the reviewed water systems are suffering from similar problems. Therefore, certain researchers have taken similar approaches and positions towards water problems. The reviewed studies have ethnoecological nature, although the writers do not announce ethnoecology as their approach. But because of their opposition to the reductionist and positivist viewpoints on water, and also due to their holistic perspective, their studies and ethnoecological discourse have many elements in common. Ethnographic fieldwork and holism are the main methods and approaches which have been used by nearly all the writers. Furthermore, participant methods, interview, and in some cases political sociology are common in many parts of the relevant literature. Meanwhile, there are some differences among the studies. Some are more comparative, while others put more emphasis on the in-depth and case-based

analysis. This difference is the basis of the separation that I have made in this chapter. Hence, the first section cases are more comparative but the second group writers investigate the broader socio-cultural backgrounds of the water systems which means their works are more context-related and case-based. Despite the differences of the reviewed works, comparison between modern and traditional, local and central model, and the consequent tensions over water are among the main themes of the researches.

As one can see, the above evaluations are negative and highly critical towards environmental effects of the physical structures of modern water management. Regarding the techno-physical practices of water management systems, the works emphasise the sustainability of the traditional management systems and the negative ecological impacts of their modern counterparts. The works argue that the Western-oriented water paradigms are habitually unaware of the limitations and pressures of local environments. These modern discourses have developed free from the local conditions and landscape and also have little to do with the environmental circumstances of the regions. In the meantime, they profoundly rely on the imposed European elements rather than local knowledge. They assess water resources in quantitative terms and as totally alienable resources (Strang, 1997). Also, they believed that they must maximise the use of resources and create constant growth (Ibid), an approach which has caused a kind of intensive resource use. At last, current water management arrangements have enormously undermined environmental values.

In addition to technical assessments of the water systems, the reviewed literature allocates more details to the socio-cultural dimensions, such as water meaning, rituals, and associated communal management systems. These socio-cultural assessments also include comparison between traditional and modern institutional structure. By reading this literature, one can realise the importance of the social constructs of water. These works can indicate that the socio-cultural constructs are not just "a glance on productive relationships" (Lansing, 1991); in fact, they have serious effects on how people manage their resources. Irrigation "is more than an act of hydraulic engineering" and "it requires institutional arrangements for the construction and maintenance of physical facilities" (Kelly, 1983). In this regard, the researchers' main argument is that more than technological developments, cultural solutions and

organisational restructurings should be implemented for water management problems. These studies assert the negative points of the modern systems and they reveal that local management models have some advantages over central and government-based systems because "the livelihood of local users depends on the resources" (Meinzen-Dick and Raju, 2002: 2). In other words, local users are automatically more responsible towards their resources, compared with managers who are physically and perceptually distant from water resources. In all the modern systems under investigation in this chapter, consumers' socio-physical engagement with water management has been at the lowest degree possible. Ultimately, the modern water paradigms have been described as uncooperative models of water use and management which are ecologically unsustainable and socially individualistic and disconnecting.

Chapter conclusions

In chapter three, I studied some ethnohydrological systems across the world that have similar characteristics and functions to the Qanat system. This chapter was organised into two sections. The first section presented a comparative review of a selection of studies of water systems. The second section included a more comprehensive and detailed analysis of three individual cases, those of Bali, Stour Valley in England, and Cabanaconde in Peru. Through the second chapter, I applied qualitative contextual analysis by studying some non-water-related contexts of each case. Conclusions related to each individual case have been discussed at the end. Finally, I summed up some comparative discussions concluded from all the cases which show negative environmental and social impacts of Westernisation of water management in the second half of the 20th century.

In the next chapter, I use the approaches and methods learnt from the second and third chapter to explore and interpret the features of the Qanat system.

Chapter Four: Qanats and Iranian Ethnohydrology

Chapter introduction

This chapter indicates that traditional water management in Iran, in addition to the technical system, included a set of social and ritual practices and a property regime around Qanat. Firstly, following the contextual method of qualitative research, I explain the social cohesion of the Qanat-watered villages in Iran. These general characteristics of rural life in pre-capitalist Iran provide an image of a feudalistic structure within which the Qanat system used to function. This wider context is beyond the technical and sociocultural levels of the Qanat system and is not directly related to water issues. After this, I discuss a typical Qanat community. This typical Qanat system includes the techno-physical aspect of the system, Boneh as the social level and Qanat marriage as the ritual dimension. Accordingly, this model contains Qanat's water managers and consumers together with the participants of water rituals as the same actors. The aim is to examine how a holistic and integrated body of technique-institution-rite worked before a countrywide change in land ownership during the 1960s. In brief, fundamental reasoning of this chapter is that the physical technology of Qanat should be understood within its broader socio-cultural arrangements. Then for this purpose, the chapter explores the links between the physical technology of Qanat with feudalism, Boneh, and some animistic rites. In other words, feudalism will be examined as the economic formation underlying this technology, Boneh as the socio-institutional aspect, and the animistic rite of Qanat marriage as the mythical- ritual aspect of this water system. Finally, my approach can reveal how a medieval feudalistic order and its traditional water paradigm could maintain a balance between individual and collective interests.

Different approaches to Qanat studies: shortage of the holistic and anthropological investigations

A quick review of the Qanat literature shows that engineering discourses are dominant in the existing Qanat literature. The key topic of the vast majority of papers which have been published on Qanat in the past few decades is the technology of Qanat construction (Jomehpour, 2009). Moreover, a sudden surge of the interest in Qanat,

especially due to population growth, urbanisation and rural–urban migration, can be observed in Iran between the 1960 and 1980. These discussions, especially in the 1960s, focus on the advantages and disadvantages of deep wells versus Qanats. Meanwhile, papers in the 1970s raise fears about the drying of Qanats because of deep wells (Ibid). Currently, Qanat is being taught as a part of three subjects at Iranian universities. These subjects contain the extraction of underground waters subject in the agricultural faculty; hydrological engineering subject in the civil engineering faculty, and the groundwater extraction subject in geology departments of the science faculty (Behnia, 2000). In addition to technical assessments, economic evaluations and law and social science research (history, archaeology and sociology) are among the disciplines that have been involved in the study of Qanat, though far less than engineering disciplines (Behnia, 2000). An example of this socio-cultural deficiency is that the word "Boneh" has never been mentioned as a system of collective agriculture in any of the historical and geographical resources available to the main researchers of the field (Safinejad, 1989: 546). Although there are many social dimensions connected to the function of the Qanat system, Qanat studies mostly have focused on techno-physical factors related to Qanats (Kordovani, 1984).

Since the engineering framework studies irrigation systems, Qanat included, as separate from society (Mosse, 2010), Qanat studies suffer from a considerable ignorance about the sociocultural dimensions of the system. The wider and deeper analysis of the socio-economic and cultural dimensions of Qanat has been a marginal trend (Jomehpour, 2009). In particular, a shortage of studies in anthropology should be emphasised. This is a weakness in comparison with many works on other traditional water management systems that investigate sociocultural dimensions side by side with technical aspects. Therefore, disconnection between technology and its social context can be recognised as the main deficiency of current Qanat studies. To summarise the main characteristic of Qanat studies, they have been carried out through what Mosse calls the "engineering paradigm". Within this paradigm, irrigation systems are often narrowly defined and the wider social systems that make them work are assumed to be unrelated (Ibid). In contrast to the "engineering paradigm" (Mosse, 2010), other holistic alternatives such as the "management framework" study more functions of irrigation systems such as water acquisition and allocation, system maintenance and conflict resolution (Ibid). Hence, in my study

after a basic description of the technical system of Qanat, I investigate the broader social structure within which this technical system works. My final goal in applying this kind of approach is to fill the sociocultural gap in the Qanat literature.

The medieval rural society of Iran as the wider context of the Qanat system

The medieval rural society of Iran is the larger social context of Qanat technology within which an ethnohydrological process takes place. Considering the main features of this medieval structure, it has been argued that a feudal-like system of loyalty and fealty has been developed in rural Iran. This feudalist system determined a water ownership regime or water law in rural Iran. So, investigating the feudalistic system of land and water ownership is worthwhile. This system was similar to some jurisdictions in medieval Europe within which all property was owned by the monarch. Although there have been some controversies around applying this term to non-European societies, the term *feudal* has been applied to non-Western societies in which institutions and attitudes similar to those of medieval Europe are perceived to have prevailed (Cantor, 1991). According to Cantor, the core concept of feudalism is the contract between a lord and his or her vassals which includes a reciprocal arrangement of support in exchange for service (Ibid). Consequently, the term feudalism has been used by many researchers to understand and explain the old system of land and water ownership in Iran.

In terms of the feudalistic social stratification in rural Iran, the population of the villages consists of the landlords and those who work on or own the units into which the village land is divided (mostly sharecropping peasants). In landlord properties, the village was the unit of ownership (Lahsaeizadeh, 2002) and the landlord was the owner of the whole village. The landlord had legal and financial control over villagers' lives (Lahsaeizadeh, 2002). Every village was divided into shares held by peasants. Consequently, landlord-peasant relationships, for the most part, are based on sharecropping agreements originating from local customs. In early times, Islamic jurists made attempts to bring this kind of relationship within the legal system. Later, in the twentieth century, the writers of the Civil Code made the same attempt. A

peasant has no right to transmit his holdings by inheritance, but it usually happens that the landlord makes an agreement with one of his sons who may continue to cultivate the land that his father cultivated before him (Lampton, 1969: 304). A certain area of land is handed over to the dead sharecropper villager's son on a sharecropping basis. Custom gives the peasant a measure of protection in some areas. For example, if the landlord sells his land the new owner cannot deprive the peasant of his rights (Lampton, 1969: 296). Although this agreement has a certain homogeneity throughout the country and these practices and customs prevail in many parts of rural Iran, it differs in detail from district to district (Ibid: 306). In the end, a peasant's tenure is not guaranteed; nevertheless, he may spend his whole lifetime in one village. This type of contract will be discussed more comprehensively later in the chapter.

It is also worthwhile mentioning that there were independent agricultural and non-agricultural producers who comprised only a small percentage of villagers (Lahsaeizadeh, 2002). Agricultural labourers, artisans such as carpenters and blacksmiths, officials such as village headmen, tradesmen, and Muslim clerics can be mentioned as some of these independent groups. Not all the classes were found in each village. Finally, the vast majority of peasant population in Iran were crop-sharing peasants or tenants and landless labourers (Lampton, 1969: 295). The villagers who cultivate the arable lands enjoy certain advantages over those inhabitants of the village who are not crop-sharing peasants. The landless labourers are differentiated from the crop-sharing peasants since they only provide labour and can be dismissed at will. As a result of this situation, one of the most notable problems has been the relations between the settled and semi-settled elements of the population. In short, production relations in rural Iran were based on feudalism, along with some marginalised independent peasantry systems. In other words, the main characteristic of the rural socioeconomic formation in Iran was the combination of feudalistic relations with a small percentage of independent peasantry production (Lahsaeizadeh, 2002). This means that independent peasantry was not very important in terms of agriculture and management of Qanat's water, since the structure of the Iranian agricultural was dominated by the landlord ownership (Lahsaeizadeh, 2002).

Regarding the rural population's mode of life and its peculiarities, it can be said that certain communal organisations existed both in pre-Islamic times and after the

Muslim conquest of Persia (Iran) by Arabs in the 7th century (Lambton, 1969). The underlying structure of the village is communal and individual rights derived from the superior right of the community. Village communities were largely self-contained. Agriculture could hardly flourish if the peasantry was disconnected; so rulers throughout the centuries recognised the benefit of treating the village as a coherent unit. Also, if the peasants had some degree of local self-government they would be more likely to cultivate the land better (Lahsaeizadeh, 2002). The daily life of the peasant and his family was largely determined by the agricultural seasons. The most important festival of the year is Nowroz or the Persian New Year, which falls in spring (Ibid: 391); the rest the daily round is broken only by some religious feasts, days of mourning, or by births, weddings and deaths. In terms of tax collection, it was easier for the government to deal with village communities as a whole. In some cases, villages were assessed as a whole and the community had a collective responsibility for paying the individual tax shares. The tendency to treat the village as a corporate unit continued until the twentieth century. Following this self-governance feature, rural communities have developed institutes and techniques of local administration (Lambton, 1969: 337). As a consequence, this self-governing feature played an important role in developing proper local water institutions.

In terms of the physical landscape, the farms are mostly attached to a parent village; hence, isolated settlement is still the exception. The site of the villages was influenced by natural conditions and the villages' layout was largely dictated by political and security considerations. The last factor includes the security factor which means protection from attacks by raiders in many parts of Iran. For this purpose, the hamlets attached to a village in most areas tended to be walled for security. For the most part, the houses of the village tend to be clustered together. The central point of the village is the mosque and the village shop. The larger villages have caravanserais (the roadside public house where travellers could stay and rest) mostly on the outskirts rather than in the centre of the village. Gardens are on the edge of the village rather than in it. The cultivated lands are mostly situated round the village. Furthermore, since insufficient rainfall and the lack of water is the limiting factor in most parts of Iran, availability of water has largely determined the location of rural settlements. Since water has to be shared for irrigation, disputes over water use were common (Lambton, 1969: 213); indeed, this fact has shaped distribution of the holdings. The

shape and layout of the village and its lands were naturally modified by the availability of water in both areas where dry farming and in those where irrigated farming was practised.

Insecurity is the background against which some features of the rural life have developed. Moreover, economic inequalities underpinned the idea of a big reform in rural Iran during the twentieth century. Peasants' position in the landlord areas depended largely on the personal qualities of the landowner. Most of the time, distrust, insecurity and intrigue prevailed on all sides of a village. Peasant poverty and low living standards for farmers were among the factors that pointed to a need for a huge rural reform. Later in the twentieth century, governments largely encouraged a shift in wealth, power, and privilege from one set of villagers to another to reduce these landowners' privileges. In summary, the dominant feature of peasants' life was insecurity due to natural causes, market fluctuations and the landlords' personal decisions. Although traditional forms of rural organisation have been suspended from time to time, they have repeatedly reasserted themselves and there has been a continuity of tradition over the centuries (Lahsaeizadeh, 2002). To conclude, the village in Iran has been from early times the component which formed the basis of social life and the unit into which the population organised economic production.

A typical Qanat system

As was mentioned earlier, to create a division between traditional and modern water management I create the picture of a typical Qanat community. This community contains a village using the Qanat system to produce and manage water. By use of the four-level framework, this typical Qanat system must integrate the various contexts attached to the system in addition to the techno-physical structure of Qanat. The first level of the Qanat system, like other traditional knowledge systems, contains detailed taxonomies and traditional classifications of the objects related to water management. Since the native terms and local language names about the Qanat system include some details which are not relevant to my research questions and aims, I start with the second level of the Qanat system which is the technical layer. The technical system of Qanat will be briefly discussed and compared with the modern alternatives, but this

research as an anthropological study concentrates on the socio-ritual aspects of the system.

The second level of the Qanat system: Techno-physical structure of Qanat

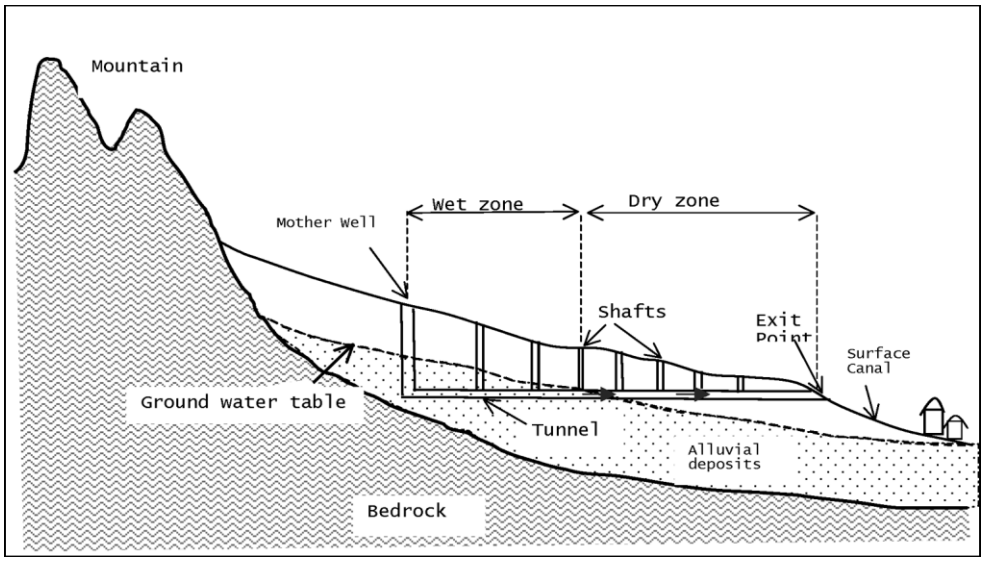
In terms of physical functioning and structure, Qanat can be described as gently sloping subterranean tunnels connecting wells over long distances (Behnia, 2000; English, 1968). In other words, the physical system of Qanat contains a set of well-like vertical shafts, or a chain of wells, connected by sloping horizontal tunnels. Qanats tap into subterranean water in a manner that efficiently delivers large quantities of water to the surface without the need for pumping. The water drains by relying on gravity, with the destination lower than the source. Qanat allows water to be transported long distances in hot, dry climates without losing a large proportion of the source water to seepage and evaporation. Qanats are relatively insensitive to levels of precipitation; a Qanat typically delivers a relatively constant flow with only gradual variations from wet to dry years, and as it relies on seepage into the tunnel, Qanats deliver groundwater in sustainable quantities. Making the physical structure of a Qanat is a highly skilled operation, in the way that the trade of the Qanat-makers (*mugannis*) was often hereditary in rural Iran. (Lambton, 1969: 218)

The following list shows the basic components of a Qanat (see figure 2):

- *Mother well:* deepest shaft located at the very end of the gallery extended into the aquifer.
- *Shafts*: wells dug at regular intervals (every 50–100 m) across the gallery to facilitate soil removal, ventilation to well diggers, and access to the subsurface canal for dredging.
- *Gallery:* a subsurface canal connecting the exit point to the mother well, usually with an ellipsoidal cross-section and a gentle or horizontal slope, with consideration given to sufficient speed and prevention of streambed erosion.
- *Exit point:* the place where the Qanat's water appears on the surface.

- *Surface canal*: a canal for carrying Qanat water to lands to be irrigated.
- *Wet zone*: part of the gallery that runs across the aquifer and supplies the Qanat with water.
- *Dry zone:* the gallery between the wet zone and exit or 'daylighting' of the Qanat (Behnia, 2000)

Figure 2. Qanat's Basic Physical Structure (Behnia, 2000)



The third level of the Qanat system: Boneh as the social structure of Qanat

What is Boneh?

Like all traditional resource management systems, Qanat also has a wider sociocultural aspect. In fact, Qanat is a remarkable social phenomenon and cannot be viewed just as an engineering wonder (Balali, 2009). The Qanat system has to be closely linked to the local community's ability to plan and manage its own water resources, especially for agriculture (Ibid). The social institution on which Qanat depends to operate properly is Boneh. This system is known by various names depending on the region of Iran. In the areas around Iranian capital, Tehran, the system is called Boneh. In the eastern parts of Iran, it is called Sahra and in the central

regions the term Harasseh is used (Jomehpour, 2009; Gholi Majd, 2000; Feyerabend, Pimbert, Farvar, Kothari and Renard, 2004). This system is similar to other ancient social traditions connected to water around the world such as Minga in the Andean region and Nafir system in Sudan (Feyerabend, Pimbert, Farvar, Kothari and Renard, 2004). Scholars have defined this typical Qanat-based collective system in different ways. Hoogland describes it as "a communal system under which the arable land of a village was organized into units farmed cooperatively by teams of sharecroppers" (Hooglund, 1982: 3). Another definition is collective organisation of production management, common in the central and eastern provinces, in the Qanat regions (Jomehpour, 2009: 303). Also Balali defines the system "an agricultural unit on which some farmers have the right to work cooperatively" (Balali, 2009: 86). Some scholars have described Boneh as a cooperative lifestyle more than just a management system (Farshad and Zink, 1997: 458) and also "a social hierarchy which defines roles and responsibilities" (Jomehpour, 2009: 304). In fact, Boneh was developed as a system of collective ownership and management of Qanat water along with some participatory practices. This social system has been the result of millennia of human adaptation to water scarcity in which villagers share the management and ownership of water resources through a complex sharing ethics among local stakeholders. Boneh, as a collective production unit, has been determining the traditional rural social structure, before modernisation of the agriculture and water management. These two technical and social phenomena, Qanat and Boneh, along with relevant value systems, were the main characteristics of the land and water management in pre-modern Iranian rural society (Balali, 2009).

Connections of Boneh and Qanat

By use of the four-level framework outlined in chapter two, technical and social dimensions of TEK systems can be investigated as two coupled levels which together comprise the practical aspect of the management system which is named "praxis" (Toledo, 1992). Due to some communal necessities of this "praxis", the feudalistic system of ownership over immovable agricultural factors (land and water) led to the Boneh system (Safinejad, 1989). Because agricultural lands in Iran mostly need

irrigation and especially Qanat's water, in the lands owned by a landlord water ownership was associated with the land ownership. As a result, if Qanat was the water resource, the landlord was the owner of that Qanat (Lahsaeizadeh, 2002). In the same way, Boneh can be described as a social structure which has been developed out of the need for cooperation in constructing and maintaining Qanats and using its water for irrigating farm fields (Jomepour, 2009). This cooperation was necessary for some functions in rural life which were beyond the administrative capacity of an individual family. In fact, the Boneh system granted land to peasants who could not otherwise afford it; thus, Boneh was providing primary production capacity (Farshad and Zink, 1998). The preparation of land, the supply of irrigation water and the organization of necessary labour, cultivation, provision and allocation of water were among other functions which were managed within this communal system. Moreover, Qanats needed social cohesion for water allocation, water distribution, water use and system maintenance, the constant need for tunnel repairs, and communal methods of water rotation (English, 1998). These factors are the driving forces behind the emergence and formation of the Boneh or the multi-family collective production, which has affected almost everything in rural communities in Iran (Balali, 2009). In other words, Boneh developed out of the agro-environmental constraints and necessities and extended to cover agricultural production and related socioeconomic systems (Jomehpour, 2009). Through the Boneh system, the method of water distribution and allocation of crops for cultivation has been intricately worked out among the owners of Qanat and agricultural land (Jomehpour, 2009). These factors maintain the social cohesion and cooperation of the Qanat-watered villages.

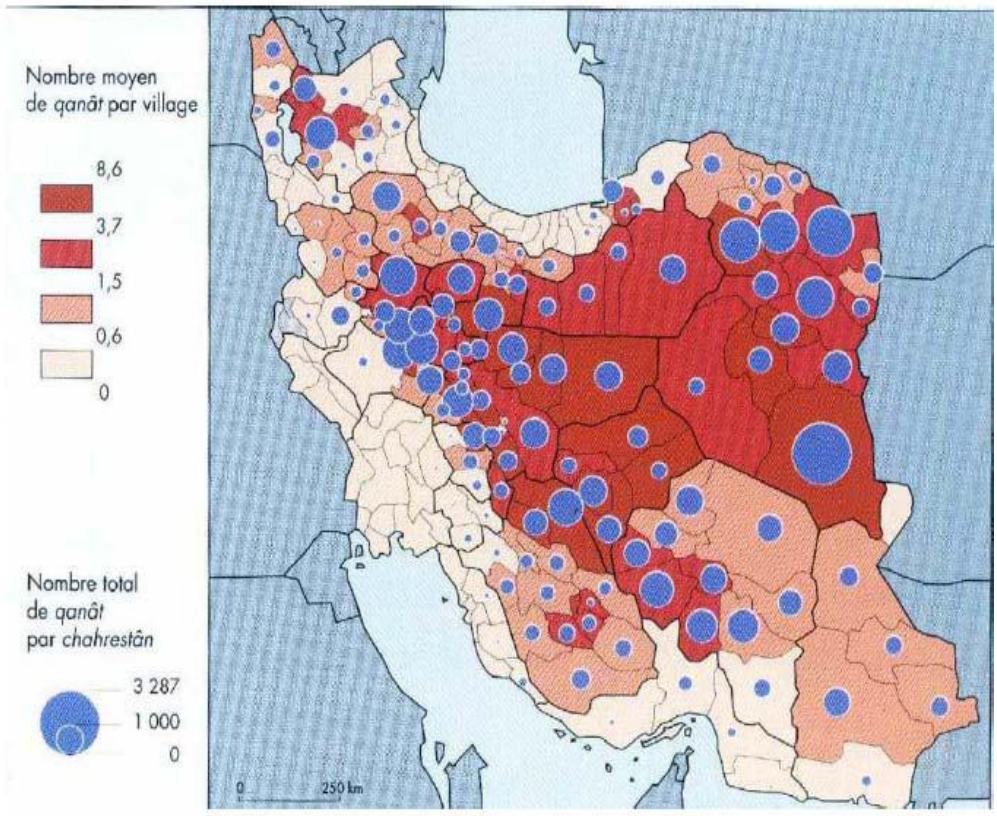
Pre-capitalist agricultural production was undertaken through two institutions of "household" and Boneh (Lahsaeizadeh, 2002: 75). This means that apart from Boneh as the collective production unit, there was a different institution for agricultural production in areas of high rainfall. This organisation was called "the familial production unit" or household. However, for most parts of Iran, agricultural activities were beyond household's capabilities due to the necessity of artificial irrigation and managing Qanat's water. In other words, agriculture in dry areas needs somebody to extract water from beneath the surface and then to deliver it to the farm fields (Lahsaeizadeh, 2002). Consequently, in most areas of Iran the familial production was not in use and agricultural operation had to be performed through the Boneh system

which contained a few agricultural households (Ibid). Based on map 2, the northern and western regions of Iran have adequate water from the high precipitation. Meanwhile, maps 3 and 4 show that the Qanat/Boneh system was mainly practised in the centre and eastern half of Iran where the climate is arid and semi-arid (Ajami, 1985; Kuros, 2007; Majd, 2000). Thus, according to these figures, Qanat and Boneh have been developed in the same localities of Iran. This means that outside of dry areas of the country, instead of the cooperative system of Qanat/Boneh, individualistic modes of production had prevailed even before the modernisation process of the 1960s.

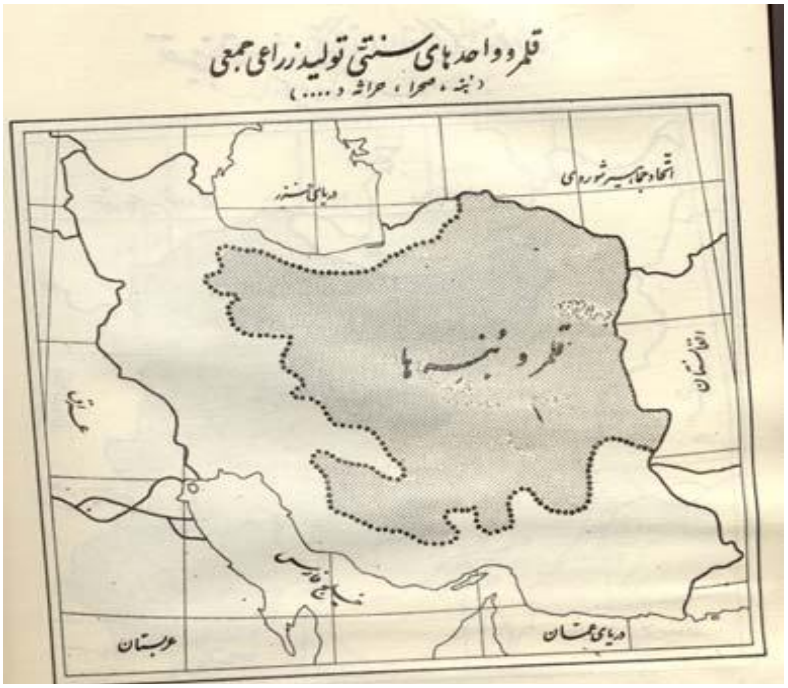
Map 2 Iran's rainfall distribution map

(http://www.worldtraderef.com/wtr_nl/WTR_site/maps_new.asp?cid=68)

Map 3 Distribution of Qanats [red part] *(Balali, 2009: 43)*



Map 4 Realm of Boneh [gray part] in Iran *(Balali, 2009: 43)*



General characteristics of the Boneh system

Boneh as a socioeconomic adaptation to harsh natural conditions (water shortage) contains certain structural and functional properties (Ajami, 1985; Balali, 2009). Hierarchical structure and peasant sharecropping are among its main characteristics. In this traditional system, cooperation was organized through the hierarchical arrangements among landlord, peasants and other people in the village. So, the system was based on the experiences of generations and a long history in which unequal positions within this set (sharecroppers and landlords) could work according to the regulations and customs that were applicable by all members (Balali, 2009). Regarding the sharecropping feature of the Boneh system, it can be said that due to this agrarian structure cultivation teams were organised by landowners for whom sharecroppers or wage labourers work and team members shared inputs and outputs. The dominant pattern of land ownership in Iran before the land reform- a large social transformation which will be described in the next chapter - was a combination of large-scale feudal land ownership with small-scale absentee and peasant proprietorship (Balali, 2009). Because of the importance of artificial irrigation to Iranian agriculture, sharecropping was commonplace among the different types of agreements between the peasant and landowner. Iranian agriculture was dominated by absentee owners who exploited their holdings through the use of various sharecropping agreements with the cultivators (Hooglund, 1981). Sharecropping rights cover "the right to farm land and to receive a portion of the harvest" (Hooglund, 1982: 23; Hooglund, 1981). Prior to the modernisation of agriculture in Iran, there were two classes of peasants. First, those who were organised in production Boneh groups and had formal sharecropping agreements with landlords (Ehsani, 2006) Second group included those who were not granted sharecropping rights by the landlord and whose work arrangements were with the sharecroppers not landlords. The second group is counted as landless agricultural labourers (Hooglund, 1973). In conclusion, Boneh can be described as a parcel of land which was owned by absentee landlords who contracted with the peasants to cultivate the land in return for a share of the crop (Farshad and Zink, 1998; Hooglund, 1982; Majd, 2000).

Boneh as an agricultural sharecropping unit was a water management institution as well. The reason was that due to the dry climate, artificial irrigation has been

necessary for agriculture in most regions of the country in the course of Iranian history. (According to current agriculture ministry statistics, 94.25% of water withdrawal is used for agricultural purposes (Balali, 2009)). Consequently, water management and agricultural systems have been interwoven, and water management has always been under the influence of the agricultural systems (Kuros and Khaneiki, 2007). Accordingly, social institutions responsible for water management have always been part of agricultural organisations; wherever farms required irrigating, there were sophisticated water management and division systems (Kuros and Khaneiki, 2007). Finally, the Boneh water management system evolved as a complex organization with distinct cultivation, water rights, and semi-structured farm management mostly for agricultural purposes.

Structure of the Boneh system

The fundamental structure of Boneh includes working on common land under supervision of the highest member and using the same water resource belonging to a landlord. Boneh was a complicated agricultural organisation which had special land and water rights. It was more than a simple collection of farm households. But also there were various socio-economic relations among the members of Boneh. Kinship and family ties played an important role in the households joining together and establishing Bonehs (Lahsaeizadeh, 2002). Each village consisted of several agricultural units (Boneh) cultivated by 6 to 12 farmers (sharecroppers) (Balali, 2009; Farshad and Zink, 1997). In other words, Boneh was "a parcel of land" (Jomehpour, 2009: 35) where its size was determined by the amount of water available for it. Water was the main factor in the formation of a Boneh. A Boneh could be established only in the case that it could get sufficient water resources (Safinejad, 1989: 112). The number and extent of Bonehs depended on the quantity of irrigation water and the area of arable land in the village, as all Bonehs had to be equal in size and receive equal shares of water (Farshad and Zink, 1997). Bonehs pooled resources not only to cultivate the land but also to pay the local blacksmith, coppersmith, carpenter, barber and bath attendant. According to the tradition, village residency entitled some peasants to Boneh membership; and Boneh membership entitled them to land as well as to communal pastures, woods, and water (Abrahamian, 2008).

Regarding the internal labour division of Boneh, each Boneh was controlled by a headman or Boneh head (*sarboneh*) who was selected by the landlord *(Arbab)* or his representative (*mobasher*). Each Boneh head had two assistants, usually people very close to him. Boneh members who worked together divided the production according to conventional rules. The landlord representative acted as an intermediary between the members of the Boneh and the landlord. The landlord or his representative's orders were given to the irrigator and the irrigator commanded the Boneh members (Safinejad, 1989: 112). Also, Boneh was a communal organisation to implement the farmers' commitments in front of landlords (Safinejad, 1989). Every farmer was responsible to the head of Boneh (*Sarboneh*) and then the head of Boneh was in charge of paying members' proprietary interest to the landlord (Safinejad, 1989). The major boss was the landlord who was regularly in contact with his representatives (Farshad and Zink, 1998). All the needs and issues of Boneh were resolved by the landlord or his representative (Safinejad, 1989: 111). A common feature of the Iranian landlords was their absence, since they lived in cities. After the Second World War, landlords were composed of army commanders, bureaucrats, some businessmen, and tribes' leaders. The main tendency of Iran's landlord community was quantitative not qualitative increase in the land they owned. Because of this, landlords preferred to have larger lands rather than more fertile regions (Lahsaeizadeh, 2002).

According to the labour division system of Boneh, in a particular village all the farmlands belonged to a landlord who divided his lands into some agricultural units on each of which a team of peasants worked. Each team usually consisted of a couple of peasants of whom one was water master or irrigator (*Abyar*), one was irrigator's assistant, and two were in charge of plowing and cultivating (*Barzgar*). An irrigator had the highest position and supervised the other members of the group, and a *Barzgar* occupied the lowest position of this hierarchy. Also, dividing the water among the agricultural units (Bonehs) was based on a particular rotation. For example, if a village had 8 agricultural units, each unit had the right to appropriate the water once every 8 days. In other words, the units took turns being irrigated. Irrigating in this way was not easy, because in some cases a Boneh was not concentrated on a unique location but consisted of different parts in different areas. Therefore, the farmers had to distribute their right to 24 hours' irrigation throughout a rotation period

of 8 days (Kuros, 2007). The distribution of water in these settlements was based on the ownership of time shares in the annual flow of a Qanat (English, 1998; Kuros, 2007; Balali, 2009).

Advantages of the Boneh System

One of the major functions of Boneh was the efficient use of productive land and Qanat's water (Balali, 2009). It is said that the main advantage of this system was solving the problem of land fragmentation. In this traditional cooperative system, by implementing production plans for the entire village and combining the cultivators into teams, the over-fragmentation of lands and the grazing problems could be overcome and field size was expanded (Keddie, 1968; Majd, 2000). In addition, to achieve the highest land fertility, cultivation of Bonehs was systematically rotated (Jomehpour, 2009). Promoting strong collaborative work among agricultural communities was another benefit of the Boneh system (Jomehpour, 2009). It strengthened the socioeconomic position of the peasants (Balali, 2009). Everybody worked and lived under the management and authority of a lord who owned the arable lands in village. The duty of each farmer was perfectly specialized: some were usually in charge of plowing and preparing the field, some were responsible only for irrigation, and some were involved in seeding, protecting and harvesting (Kuros and Khaneiki, 2007).

A measure of social mobility was evident within the hierarchy of a Boneh. Boneh members could be promoted according to some regulations; as a result, their rights and social status were raised. A normal member of a Boneh *(Barzgar)* could be promoted to the position of irrigator (*Abyar*), the highest position in a Boneh (Safinejad, 1989). In this system, if a *Barzgar* could ensure his qualifications for a higher position he could be promoted to the irrigator's position and even to the landlord's representative. Also, the irrigators who headed the Bonehs did their best to compete with one another by optimizing irrigation. In doing so, they could increase their production, which was of great importance to the lord. The better an irrigator could manage his team, the more he could produce and the more value he was to the

lord. The irrigator had to put in considerable effort to satisfy the lord's expectation, otherwise he ran the risk of losing his position (Kuros and Khaneiki, 2007).

Efficient management of water, the scarcest input of agriculture, resulted from the Boneh system (Balali, 2009). This efficiency had two reasons. First, the traditional system of land ownership and tenure, and the socioeconomic organization of Boneh, were well adapted to the optimal use of the Qanat system (Ehsani, 2006). Farm lands of landlords had no value without Qanat; consequently, cleansing Qanat was the landlords' responsibility; so, they tended to clean up Qanats (Lahsaeizadeh, 2002). If a Qanat needed repairing, the lord did not hesitate to call in the Qanat practitioners and finance the whole project (Kuros and Khaneiki, 2007). Qanats were carefully protected and Qanat maintenance was a professional job for a class of villagers within the rural agrarian structure. The second reason for irrigation efficiency within the Boneh system was that irrigators had professional expertise in irrigation. Irrigators were chosen from a large number of farmers, since irrigators had to go through different stages of membership of Boneh and should have proven their abilities in cultivation and harvest. There were also some "hidden competitions to achieve the irrigator position" (Safinejad, 1989: 112). In the Boneh system, an irrigator was familiar with the geographical distribution of lands and the way in which the Bonehs should be irrigated best (Kuros and Khaneiki, 2007). In a system of Boneh, only the irrigator was capable of irrigating and others were experienced in other jobs such as plowing, seeding, and etc. Therefore, no-one could irrigate as well as an irrigator did. Furthermore, the customs and laws within the Boneh system regarding water were well adapted to the local conditions because they go back often to the pre-Islamic times and the early Islamic codification (Wulff, 1966). These customs have experienced a long process of trial and error by subsequent generations of the local residents. The water management system in Boneh is such that the water is distributed according to the rules of the community, and this results in water security (Balali, 2009). Interaction among farmers in the system of Boneh was so efficient that there was some excess water left by which more land could be irrigated (Kuros and Khaneiki, 2007). No agricultural unit was short of water in a Boneh system, and the benefits and costs were always kept in balance (Farshad and Zinck, 1998).

The likelihood of various interrelated activities which enabled communities to mitigate a range of risks was another value of the Boneh system. This advantage of Boneh resulted in a traditional integrated farming system that was a complex system of unified activities which included three main components: crop farming, animal husbandry and handicraft production. The output of one activity may become the input to another one. In this way, the primary farm products are increased constantly, either for auto-consumption or for sale. Functional integration and temporal distribution of the activities ensure that all family members participate full-time all year around. The large variety of products generated helps mitigate all kinds of risk, from climatic (drought, late frost) to economic (market price fluctuations, product scarcity). Such integration is the end result of an enduring co-evolution between ecosystem and social system (Balali, 2009).

Disadvantages of the Boneh system

As was pointed out in the second chapter, romantic admiration of indigenous knowledge and management systems is a common fault in some parts of ethnoecological literature. Consequently, awareness of the weaknesses of traditional systems is lacking among some indigenous management researchers. Despite some scholars who only have appreciated the positive points of the Boneh system (English, 1998; Jomehpour, 2009), there were also some flaws which became the catalyst for an agricultural transformation and ultimately a modern paradigm of land and water management. As stated by Mosse, relying on indigenous systems is not so simple because of inequalities associated with them (Mosse, 2010). Mosse's point is related to the main disadvantage of Boneh that frequently has been pointed out by critics, particularly to justify implementation of land reform in the 1960s. This feature includes a hierarchical inequality and class stratification which causes the unequal division of labour and crop (Balali, 2009).

In terms of class stratification, Boneh was also a pattern of class division or stratification among the peasants in virtually every village (Keddie, 1968). The Boneh system reflected a person's social and economic stature in the village (Jomehpour,

2009). Iranian villages generally contained two distinct social classes before abandonment of the Boneh system. One social class was dominated mainly by farmers and peasants who cultivated land. Meanwhile, there was a very small percentage of independent producers who were not under control of any dominant social group. These independent producers included landless non-farmers who engaged in various commercial, services and labour activities appropriate to an agricultural economy (Hooglund, 1973). Water officials worked as the landless part of this class stratification. On the other side of this rural social stratification, the landlord and his representatives comprised the wealthy and dominant classes of villages (Safinejad, 1989: 110). Within the Boneh system, like many indigenous systems everywhere in the world, upper castes were entitled to privileged rights (Mosse, 2010). The heaviest jobs were allocated to the lowest member of Boneh and the easiest work was awarded to the highest member (Safinejad, 1989: 546). Boneh members did not have independence in cultivation since the type and the amount of cultivation depended on the lord's wishes. Indeed, the landlords could command all the Bonehs of a village under their ownership and management (Safinejad, 1989: 112). All the needs of Boneh were supplied by the landlord's power and funds; consequently, local rules and customs supported the landlord's interests (Safinejad, 1989: 397). According to this discriminatory stratification, the products were not distributed among the peasants and the lord very fairly. In the old regime of landlord and peasant, product division was based on the system of ownership over productive factors of water and land (Safinejad, 1989). The final shares of the Boneh members depended on their position in the system. Usually, the head of Boneh received more than the others and, in the end, farmers received a smaller share than all other members (Lahsaeizadeh, 2002). When the lord provided the peasants with land, water, plowing ox, and seed, he could appropriate one-fifth of the crop for himself. As a result, a big group of peasants had to content themselves with the rest. Besides, other external people who gave services to the farmers during a year, such as the carpenter, mason, blacksmith and barber, also shared in the rest (Balali, 2009: 57). The basic character of the pre-land reform agricultural regime in Iran was often critized. Briefly defined, according to this old hierarchy, a minority of owners derived profit from farming by exploiting the labour of the majority of villagers (Hooglund, 1982). Some critics have pointed out other shortcomings. The lack of individual freedom and the conservative functioning of the system that emphasised existing

sociotechnical arrangements instead of innovation (Kiddie, 1968) are among them. Recognition of these disadvantages can help us identify the difficulties of applying this traditional system to a practical model in modern contexts.

Level four: Qanat Marriage as a sample of the Qanat-related rituals

Introduction to water rites in Iran

Water rites and associated beliefs create the intellectual level (level 4) of Iranian ethnohydrology. There is a variety of water related rituals in Iran which can be labelled as a set of sacred and rainmaking dramas. Sacred watermaking dramas are held in different regions of Iran during drought years. Some researchers are convinced that most sacred dramas in Iran and elsewhere in the world are various shapes of fertility rites (Mirshokrayi, 2002). More specifically regarding the marriage ceremony of water resources, some researchers have pointed out the marriage of springwater and river in some villages (Baghdasarian, 2002). Regarding the Qanat system, the waters of Qanat were held sacred, and believed to have a human-like personality. Consequently, the protection and care of the system often involved some ceremonial rites (Balali, 2009: 73) such as Qanat marriage. Although the marriage of female Qanat has been observed in some regions, the marriage of Qanat was mainly practised for a Qanat which local people believed that he was male in the case that the Qanat discharge decreased or ceased. Therefore, of these water rites, I selected the male Qanat marriage for this study. I intend to indicate how this ritual and some associated beliefs contributed to the body of water ethics and values and accordingly to traditional water management. To do so, I have drawn upon some relevant theories about Animism, intensification and fertility rites.

Local people believed that if a supposedly male Qanat was drying up, the water inside the Qanat was looking for female water. According to villagers, to stop the male Qanat water drying up, villagers would select one of the women from the village and carry out a marriage celebration for the woman and the male Qanat. Once she had "married" the Qanat, she was not allowed to marry a man since she was deemed already to be married. The Qanat's wife received a share of the annual crops in return

for her marriage. The quantity of produce which should be donated by every farmer depended on the size of his farm. The wedding ceremony is the same as a human marriage celebration, featuring music, dance, and donating food which some believe is the symbol of demanding grace from nature (Safinejad, 1980). The Qanat's wife also had to be a widow and should wash herself in the exit point of Qanat. Farmers believed that in this way the Qanat gets excited and this excitement makes his water increase. In Ben, one of the villages in western Iran, the villagers last arranged a marriage for the village's Qanat a few decades ago. The participants of the ceremony have claimed the water of Qanat flowed two hours after the marriage ceremony. The Qanat's wife had to sit naked at the water exit point a few times per year to prevent the Qanat water's desire for female water. In some other villages, the woman must have symbolic sexual intercourse with the Qanat by washing herself in the exit point of the Qanat once a week. Consequently, the Qanat's wife gets a share of the crops grown every year. During the cold winter, the Qanat's wife, instead of bathing in the exit point of the Qanat can just perform the Islamic act of ablution (Wudu: washing some parts of body before praying) using the Qanat's water. In Alimabad, a village located in the central regions of Iran, some locals believe a Qanat's water was increased after his marriage ceremony in 1971 (Safinejad, 1980). Although the women in the village were convinced this marriage was effective for increasing the Qanat's water, but the men's opinion did not support this rite. Male villagers do not take this ceremony seriously any more and claim that people used to believe in this ritual in the past. Nevertheless, the Qanat's wife remains much respected among villagers who believe her marriage to the Qanat caused an increase in its water (Safinejad, 1980). Finally, it can be concluded that the performers' final aim in this ritual is demanding more water from nature.

As can be seen, some mythological metaphors have inspired the Rite of Qanat Marriage. The rite is based on the belief system of femininity and masculinity of waters and personhood of Qanat. Also, Qanat marriage is obviously inspired by the characteristics of human sexual intercourse. According to some researchers the belief in femininity and masculinity of waters is similar to belief in femininity and masculinity of sun, stars and moon in the Iranian folk cultures. This belief goes back to the era of worshiping Anahita which is the divinity of "the Waters" in ancient Iran (Bastani, 2001). Male and female water traditionally possess different qualities. Based

on villagers' belief systems, if water moves fast and makes loud noises it is male. Male water contains minerals, is muddy and heavy to drink. In certain areas, locals believe if the skin of a Qanat digger's feet and hands cracks and becomes roughened by working in a Qanat, the water there is male. Male Qanat's water has fluctuations. Therefore, if a male Qanat is drying up he needs to get married ;otherwise, the Qanat water will be looking for a wife and consequently it will totally dry up (Safinejad, 1980). Farmers and rural people believed that female water; on the contrary, is soft, silent and moves without noise. According to them, if a Qanat digger's skin becomes soft at the time of working in a Qanat, the water is female. A female Qanat has light water which is clear, moves slowly and includes few minerals. In addition, a female Qanat has a constant flow of water through the year. Under the influence of these sexual and gender-related metaphors, the woman is regarded as the symbol of fertility, ;thus, the sexual-like relationship of a Qanat with her causes an increase in the amount of its water. To sum up, the Qanat marriage rite includes the belief in masculinity and femininity of waters and also treating the Qanat as a person rather than an object of exploitation.

The marriage ritual of Qanat is an animistic rite. Animism reveals worldviews and practices of indigenous people which attribute life and personhood to objects and natural phenomena. This tendency of animating and more distinctively anthropomorphising nonhumans is shared by many traditional communities in regard to their natural resources. Thus, a quick review of the most recent arguments on animism is relevant. The older use of the term animism connotes confusion between persons and objects by indigenous people. This older usage alleges belief in spirits and confusion about life and death among some indigenous people. An early origin of the term or "old animism" carries assumptions that align with colonialist worldviews. This usage constructed animists as people who could not distinguish correctly between things and persons (Harvey, 2005). This is because people's talking and socialising with things like water or dancing and singing for them does not make sense in the modern paradigms (Bird-David, 1999: 78); so, some scholars believe that modernist perspectives have projected animism as a simple religion and failed epistemology (Bird-David, 1999). Recent scholars have viewed the concept from a holistic viewpoint. For understanding animistic practices and beliefs, the new animism researchers have viewed these beliefs within the wider social and

environmental relationships of a community. According to the new animism concept, animists are the people who recognise that the world is full of persons, only some of them are human, and that life is always lived in relationship with others. In this way, animism is about learning how to act respectfully towards and among other persons. Persons are beings rather than objects, who are animated and social towards others. In an animists' viewpoint, a person is someone who responds to or initiates approaches to other persons. Accordingly, the core meaning of the term is respect, reciprocity and knowing how to behave appropriately towards non-human persons. The new animism literature defines animism as theories and practices of realising how to live in the company of other persons, some of them non-humans, who are worthy of respect because of their importance to the survival of society. Since natural resources are the main subjects of this form of belief, animism can address contemporary issues of environmental conservation (Harvey, 2005). Animism concerns the widespread indigenous understanding of this fact that humans share this world with a range of non-humans as persons. It makes a big difference if we regard a crucial resource of society as a person towards whom one must behave respectfully. Therefore, animism impacts on the communities' sustainable relationship with the environment. This term can indicate some negative impacts of modernity in regard to natural resources management and indicates that the project of modernity has been dangerously performed (Ibid).

In addition to the animism arguments, two other concepts can assist in understanding the role of the Qanat ritual in the traditional water paradigm in Iran. Anthropologists have identified a group of rituals as "rites of intensification" (Bates and Plog, 2003). Intensification rites are related to a whole society or to nature; in fact, the change which is expected by participants is strengthening a natural process necessary to the survival of society. Fertility rites, as a specific class of the intensification rites, are a variety of sympathetic magic in agricultural societies. In the fertility rites, the forces of nature are to be influenced by the example acted out in ritual or magico-religious ceremonies. These rites are expressed through different forms like dances, prayers, incantations and sacred dramas. In agricultural societies like rural Iran, subjects of the fertility ceremonies are usually water-related issues like rainfall, the productivity of the earth, etc. Water rites may be classified as different expressions of "fertility rites" and "the rites of intensification". By demanding water from spiritual forces, the

general purpose of various water rituals has been watermaking. Like animism researchers, some ecological anthropologists also are convinced that these rites can play an adaptive role between local communities and their natural resources (Bates and Plog, 2003).

There are strong links between Qanat marriage and the theories discussed above. Many core animistic beliefs could be identified in this ritual; thus, Qanat marriage may be described as a fertility or intensification rite which is based on animistic beliefs. Despite modernist theories of the past which have misunderstood animism as a simple religion and a failed epistemology (Bird-David, 1999), many recent scholars assert the environmental outcomes of animism, intensification and fertility rituals. Strang's (2006) long discussion in "The Meaning of Water" reveals how each water meaning and value influences the patterns of water use and management. Anthropomorphising water – the attribution of human characteristics, motivations, feelings and needs to water – regulates respectful not exploitative relationships with water resources as persons. I used the above theoretical arguments to understand the animism and anthropomorphism of traditional water management in Iran. The arguments about new animism, intensification and fertility rites indicate that the Qanat marriage rite contributes to people's careful treatment of water. Qanat's water users and managers are the performers and participants of the Qanat marriage. This engagement in the ritual can lead to the awareness of water restrictions which is the perceptual outcome of the ceremony. In addition to the community members' personal participation in the rite, they are expected to involve themselves in the ritual by providing the cost of the ceremony or covering the living costs of the Qanat's wife during the year. In this way, villagers are also financially engaged in the ritual practices of the Qanat system. To sum up, the set of beliefs and practices of the Qanat marriage together with its socio-financial obligations for villagers, have the potential to regulate sustainable water use and management. These beliefs and practices – which were abandoned by the introduction of the modern individualistic water management – could develop a system of moral support for the traditional socio-technical arrangements within which water receives more respectful treatment. In the conclusions chapter, I will discuss more about how this ritual aspect of the Qanat system functions within the holistic water paradigm and in relation to other levels of the system.

Chapter conclusion

In this chapter, I have investigated levels of the Qanat system as different aspects of the same social process. Following a qualitative approach, I used a contextual technique to investigate the larger context of the Qanat system. To implement the contextual approach at two stages, first I explained the non-water-related context of the technology which includes general social characteristics of rural life in Iran during the centuries before the modernisation. Then after a review of the technical structure of the system, Boneh was examined as the social system of Qanat together with Qanat marriage as its ritual aspect. I tried to show how the associated socio-ritual dimensions of Qanat can affect water use and management.

The next chapter is allocated to study of modernisation of agriculture and water management and the consequent collapse of the Qanat-Boneh system in Iran.

Chapter Five: Modernisation of Water Management

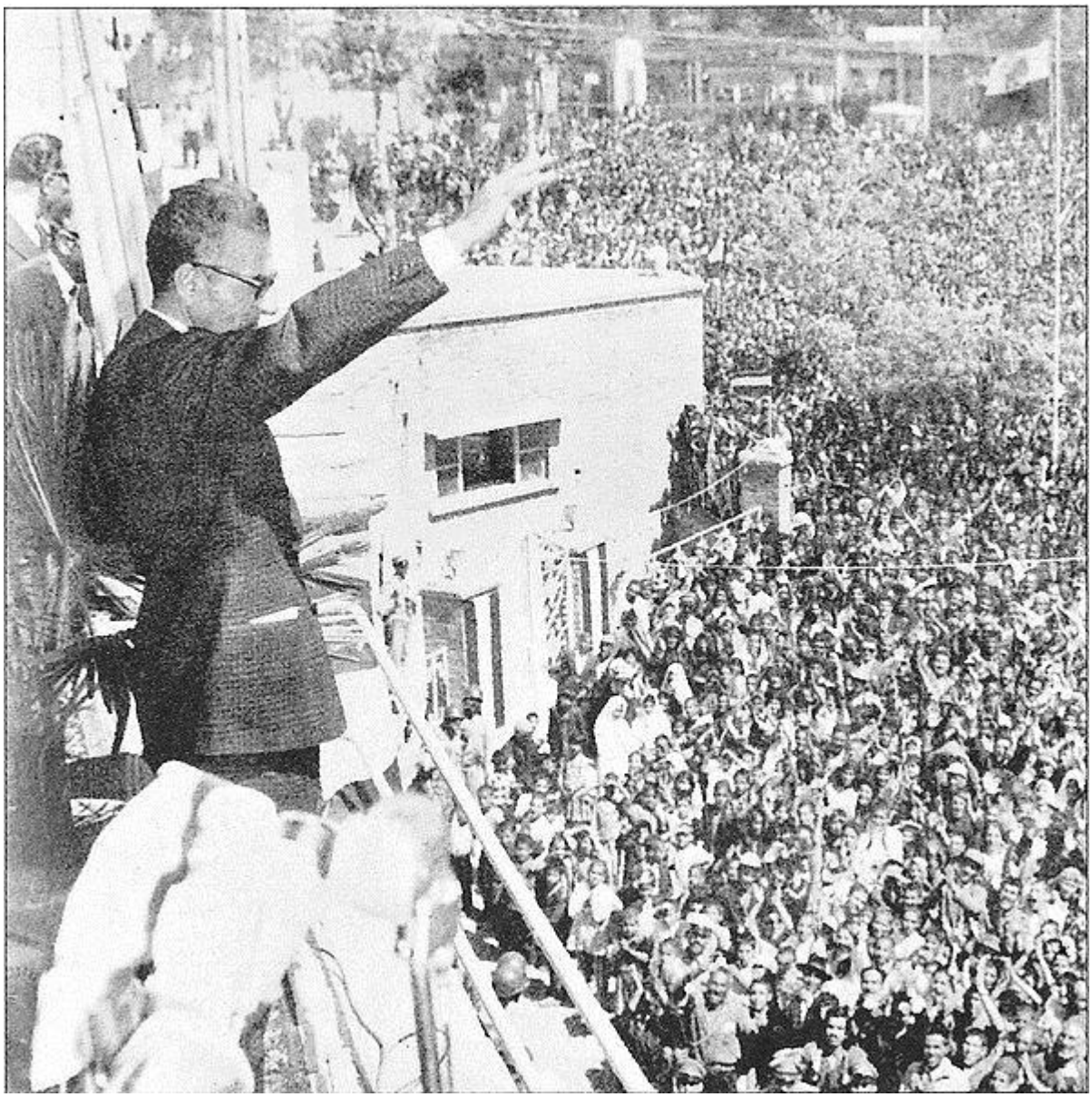


Plate 1 The Shah speaks to people in Iran about the principles of the White Revolution, 1963 (http://en.wikipedia.org/wiki/File:Mpr1963.jpg)

Chapter introduction

In this chapter, I argue that as I applied qualitative contextual method to investigate the broader sociocultural context of the Qanat system in the previous chapter, technical and social levels of modern water management also have their own wider context. This context is the modernisation process of Iran which includes a set of measures which led to the introduction of capitalistic agriculture and ultimately a social reorganisation across the country known as the White Revolution. Accordingly, the overall shift in the water paradigm can be understood within the larger context of the White Revolution and particularly by considering the most significant part of this social transformation, which is the Land Reform Law. Following this socio-technical transitions, I discuss the reasons behind the inefficiency of the new water technologies and rural institutions which are the modern equivalents of the Qanat-Boneh system. Technical and socio-institutional changes of the water paradigm overlap in many ways. As a result, in some occasions in this chapter, the technical and social aspects, as coupled levels, may not be strictly separated.

The White Revolution and Land Reform Law as the wider contexts of the Western-oriented water paradigm in Iran

The larger social context of the Westernisation of water management in Iran involved policies such as the White Revolution and particularly land reform in the 1960s. These policies were part of the broader clash between feudalism and capitalism in the agricultural sector of the Iranian economy. There is a consensus among scholars (Safinejad, 1980; Rezaei-Moghaddam, 2006) that the land reform of the 1960s was the turning point towards an agricultural transition and accordingly modernization of the country (Balali, 2009). The primary aim of the former Iranian government, like many other twentieth century governments, was industrialisation in the context of the increasingly centralised planning and control of the distribution of resources (Ghaffari, 2006). Industrial growth was a major national goal; so, the rural areas were seen as the source of labour for the cities and urban sector (Bonine, 2001). To achieve those goals, the White Revolution was launched as a series of social and economic reforms in Iran in 1963 by the Shah Mohammad Reza Pahlavi (Amid, 1999). This

involved a general reorganisation of the country through a social revolution, with the long-term aim of transforming Iran into a global economic and industrial power (Lahsaeizadeh, 2002).

The Shah of Iran advertised the White Revolution as a step towards modernization, but he also had some other political and economic motives. He hoped to eliminate the landlords' influence and create a new base of support among the peasants and working class. These series of measures, such as the land reform, symbolized the determination of the centralizing regime to assert its own authority in the villages by enforcing capitalist relations into the traditional patterns of Iranian agriculture (Hooglund, 1982). This sudden transformation indicated the obsession of Iran's former pro-Western regime to modernise the country as fast as possible. However, it quickly became obvious that the White Revolution lacked the technical, managerial, and organizational power it needed to succeed. Land reform law was the focus of the White Revolution and was regarded by the government as a precondition for modernisation of rural communities in Iran. Also, land reform is the most relevant part of this transformation regarding water management. It has been said that the pre-capitalist agricultural system in Iran and the type of land ownership and land tenure were the biggest obstacles for capitalism in Iran's agriculture (Lahsaeizadeh, 2002). Consequently, foreign investors found Iran's feudalism the main obstacle for larger investment in the Iranian economy (Lahsaeizadeh, 2002). In this direction, the US government put heavy pressure on Iran to carry out land reform (Lahsaeizadeh, 2002). Consequently, according to some experts, to understand the mutual interaction of pre-capitalist and capitalist structures, rural structures should be understood as parts of the global capitalism economy (Lahsaeizadeh, 2002).

With the land reform as the most important element of the White Revolution, the direct and aggressive penetration of rural society by the state and market had begun (Ehsani, 2006), and capitalistic relations in Iran's agriculture found ways to expand. It should be mentioned that the capitalistic relations of production were not created immediately, but after elimination of feudalism some transitional productive systems emerged (Lahsaeizadeh, 2002). The expansion of capitalism in Iran's agriculture took place in two ways. First, independent peasantry agriculture was a direct result of land reform law. These independent peasants, who could own the high quality land, had

strong control over rural life, while they were supporting the governments' interests in villages. This group of villagers had a strong tendency to take over poor peasants' lands. This class of villagers still engaged in agricultural production in rural areas after the Islamic revolution, although conditions after the 1979 Revolution did not favour them (Lahsaeizadeh, 2002). The second and more direct way of developing capitalistic relations in agriculture was by establishing capitalist agricultural units. From the villagers' viewpoint, these units replaced former landlords with this difference: they exerted their power only through economic means despite former landlords who sometimes used violent coercion over farmers and villagers. The owners of these units lived in cities and agriculture engineers were responsible for managing them. These units benefited from all the public and private facilities, machinery, and modern irrigation. Thus, these two groups have strong control over rural economy (Lahsaeizadeh, 2002). Finally, land reform greatly increased the power of the central government at the expense of other social classes, above all the landlords in rural areas (Hooglund, 1982; Ehsani, 2006). As Hooglund shows, one of the most important aims of the program was transferring authority from landlords to government but this did little to benefit the peasants (Hooglund, 1982).

During the land reform two immovable agricultural factors (land and water) were granted to farmers. Consequently, peasants became dominant in the production process, and Boneh members were entitled to equal rights through land reform. In other words, Boneh members became owners of all factors of production in agriculture (Safinejad, 1989). Land reform at the operational stage included massive redistribution of lands from large landowners to small farmer families and to many of those who held cultivation rights to specific parcels of land or water (Bonine, 2003). This land reform eventually redistributed about one-half of private agricultural lands to the peasants holding traditional sharecropping rights. This happened in a way that the land and water which already had belonged to landlords were given to peasants. By giving equal rights to peasants, landlords were compelled to sell 20 million acres which were redistributed among nearly two million peasants (Balali, 2009; Hooglund, 1982). Also, the land reform substituted government agents for the landlords. In effect, the authoritarian and centralized state eliminated the feudal landlord class and created a new class of small, independent peasant proprietors, a class of modern large-scale capitalist farmers, and also the large-scale agro-industrial projects (Ehsani,

2006). The Land Reform Act of 1962, by the industrialisation of agriculture and the creation of large agribusiness units, changed the whole organization of the agricultural production system in Iran (Ghaffari, 2006). In terms of water management, the land reform of the 1960s caused large techno-physical and social modernisation in water management. This process included transformation of the social institution of water management from the Boneh system to the new cooperatives and also a technological change from Qanats to deep and semi-deep wells.

Plate 2 Shah distributing land deeds
http://en.wikipedia.org/wiki/File:WhiteRevolution.jpg

The Replacement Process of Qanats with Deep Wells

Traditional upkeep of the irrigation system was based on the landlord-peasant ties. Accordingly, deterioration of the Qanat system by introducing the Western-oriented methods was a result of the land reform law. Also, " hydraulic mission" (Balali, 2009, : 105) is a water paradigm which was introduced to the developing countries like Egypt, Iran and other parts of the MENA region (the Middle East and North Africa) in the second half of the twentieth century. As a consequence of this new management regime of deep wells and large dams, many traditional values and practices surrounding water were replaced with a mechanistic worldview. Following this

modern paradigm, the Iranian government in the 1960s assumed that the water management sector should be industrialised by drilling deep wells to make water resources more available. Owing to the use of these new technologies, the "Age of Qanats" came to an end (Kuros and Khaneiki, 2007: 205). In this way, a mechanistic worldview appeared in which society and its natural resources were disconnected. The core belief of this mechanistic materialistic worldview was that natural resources, water included, should be exploited as much as possible by the means of science and technology (Balali, 2009).

To modernise water management, the Iranian authorities tried to diminish traditional irrigation both technically and socially throughout the land reform program in the 1960s. In pursuit of this goal, many scholars and policymakers began to exaggerate some social and physical weaknesses of Qanats. Since 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, government officials begun to persuade farmers to use deep wells instead of Qanats (Balali, 2009). Consequently, during five years the number of deep wells doubled (Kordovani, 1984). At present, there are more than 350,000 deep and semi-deep water wells throughout the country and many of them are being exploited without permit (Balali, 2009). Qanats, which supplied 70 per cent of water needs before the 1950s, were in use for providing 50 per cent of water around 1950 and 10 per cent in the year 2000 (Balali, 2009). Finally, development of the modern technology of deep wells made it possible to use groundwater resources for urban, agricultural, industrial and domestic purposes on a large scale. Water production has considerably increased but this process resulted in many catastrophic impacts, including deteriorating Qanats due to overexploitation of the aquifer by deep wells (Kordovani, 1984). Furthermore, a large number of these invaluable hydraulic structures are vanishing annually, which in turn has led to mass migration of the villagers whose lives were completely dependent upon this system for irrigation. Referring to the three year drought of Iran by the summer of 2001, Foltz believes the current water problem is due to water mismanagement not drought itself, since Iran has always had cycles of drought (Foltz, 2002). To sum up the present situation in Iran, groundwater resources have been thrown into disorder because of a lack of integrated water management (Khaniki, 2007).

Creation of the new cooperatives as the alternatives of the Boneh system

As explained in the previous chapter, social institutions of water management have always been part of the agricultural organisations in Iran. Therefore, their change and transformation should not be studied in isolation but must be analysed within the general agricultural transformation of the Iranian society. As another consequence of the land reform law, other social ties around the Qanat system were dismissed as well. Therefore, destruction of much of the organisation of rural society, including the loss of Boneh, resulted from this reform (Bonine, 2003). The sudden institutional change due to the land reform contains a transition from the Boneh system to the modern governmental farm corporations in the 1960s. In fact, the collapse of the Boneh system was caused by certain effects of land reform, such as the increase in the number of owners because of inheritance and the degradation of Qanats (Balali, 2009). Through land reform, land and water were distributed among farmers and sharecroppers; therefore, every former member of Boneh became owner of land and water. All aspects of a Boneh's function were offered to a farmer; as a result, no Boneh could exist anymore (Safinejad, 1989). In this way, the special role of Boneh members in the hierarchical structure of the organization was also terminated (Balali, 2009). This abandonment created an institutional vacuum (Wijayaratna, 2004). Although officials were concerned about the lack of real growth in the agricultural sector, they tended to attribute poor performance to the peasants' ignorance. This attitude was behind the policy of establishing government-managed farm corporations and cooperatives (Hooglund, 1981).

Land reform officials believed that rural cooperative societies and also generous support of farm corporations, agribusinesses and large-scale commercial farms could replace the Boneh system and would fill the gap caused by its annihilation (Balali, 2009; Hooglund, 1982). To improve the production of the small and fragmented production units, Agricultural Production Cooperatives (APCs), were introduced (Balali, 2009). The main purpose of these agricultural and rural cooperatives was adoption of communal cropping patterns, joint cultivation and marketing (Ajami, 1993). These organizations were mostly involved in producing and supplying agricultural inputs as well as other supportive activities such as granting credit or training and instructions (Wijayaratna, 2004).

In rural areas, cooperative societies rapidly expanded after the implementation of the land-reform program (Ajami, 1993). By December 1963, nearly 2000 cooperative associations had been formed (Balali, 2009) and also the Central Organization for Rural Cooperatives (CORC) was created and took over establishment and supervision of rural cooperatives (Ajami, 1993). Altthough modern cooperatives initially were created as the independent corporations, they gradually came under state control (Ibid). The government began to provide technical and financial assistance to the peasants and tenants receiving the land (Ibid). The corporations were established, staffed and managed by the government. Also, the government provided financial support for road construction, irrigation systems, electricity, workshops, stores and office buildings through the ministry of cooperatives and rural affairs. This period of rapid expansion initiated by land-reform also continued in the subsequent years until the 1979 Revolution (Ibid).

Comparison: technical and social assessment of the changes

Different Opinions toward Qanat / Deep Well Issue

Studies in the field have mainly compared the technical aspects of traditional and modern water management in terms of their impacts on the ecosystem (Behnia, 2000; Kordovani, 1984; Balali, 2009). A contest between two opponent groups, supporters of Qanat and of deep/semi-deep wells, has been the dominant discourse instead of impartial scientific judgment (Behnia, 2000; Kordovani, 1984). Nevertheless, there are currently three approaches or paradigms regarding the Qanat / deep well question. First, supporters of the deep well or the "industrial modernity paradigm" (Balali, 2009) who believe that Qanat is not suitable in the world today; so, according to them the drying up of Qanats is not a problem. The second group consists of serious defenders of the Qanat system who argue that deep wells disturb the balance of underground waters. A third group has been identified as supporters of the "reflexive paradigm" (Balali, 2009). This group comprises the experts who have been persuaded that we should use Qanats as long as possible and then implement deep wells only under circumstances in which Qanats cannot solve the problem. The third approach is

a combination of the first two paradigms (Balali, 2009, Kordovani, 1980). In fact, the third group believes in the integration of traditional and modern technological infrastructures.

Environmental Comparison of Qanat with Deep Wells

To summarise the environmental advantages and disadvantages of each system, we can point out the short life of deep wells compared to Qanats that last for centuries (Behnia, 2000; Safinejad 1980; Kordovani, 1984). Qanat is not dependent on electrical energy, oil or mechanical and electrical tools. (Behnia, 2000; Safinejad, 1980; Kordovani, 1984; Gharabaghchi and others). The cost of digging a Qanat is more than a deep well, but in terms of maintenance charges, a Qanat costs a third less per year to maintain (Safinejad, 1980; Behnia, 2000). In terms of environmental effects, many scholars have asserted the sustainability of Qanats. Qanats do not damage underground waters either quantitatively and qualitatively because of the gradual use of water in the Qanat system. They keep groundwater resources balanced in the aquifers even during the most severe drought, they also prevent groundwater from being discharged and also control the salinity in soil (Behnia, 2000). Some regard Qanats as more suitable for low-cost rural water supply, since it is reliable in the periods of drought and infrequent recharge (Abdin, 2006). Since Bonehs are vital for the sustainability of the Qanat system (Wessels and Hoovghan, 2002), in addition to the environmental benefits, the Qanat system can be called a brilliant pattern of cooperative work. Some have argued that the social dimensions of Qanat are more important than its ecological benefits (Behnia, 2000). Finally, the major defect of Qanats according to English is that they "cannot increase production to meet modern demands" (English, 1998: 5).

In contrast to Qanat, which works in harmony with nature (Gharabaghi & others, 2006), deep wells damage groundwater due to overpumping (Behnia, 2000). A large number of deep wells have been dug since the 1960s when this Western-oriented water technology was introduced in Iran. At the moment, there are more than 350,000 deep and semi-deep water wells throughout the country, many of which are being exploited without permits (Balali, 2009). The most dramatic impacts of this situation,

were falling water tables, drying up Qanats, and salinity of groundwater. Given the fact that extraction of water by deep wells takes the water table away from the access of Qanats, this resulted in the abandonment of a large number of Qanats in Iran (Balali, 2009). Consequently, drying up some Qanats has caused a mass migration of villagers; so, deep wells have been evaluated as being damaging for the long-term survival of long-established settlements (Behnia, 2000; Kordovani, 1984; Gharabaghi & others, 2006). Certain scholars have referred to the current situation as despoliation of groundwater resources and warned that if this process continues the same fate of Qanats will await deep wells which will become dry and unusable like many Qanats (Kordovani, 1984). Moreover, the excessive exploitation of water through wells has resulted in a negative water balance in most areas, and has accelerated the trend towards desertification (Balali, 2009).

What took place for the physical system of Iranian Qanats has happened everywhere: decision-makers have sacrificed long-term sustainability for short-term economic benefits. In Israel, the US and India, overuse of modern hydrological technologies such as huge dams and groundwater pumping has had disastrous effects (Foltz, 2002). The situation has been the same in Syria, where Syrian Qanats, which have been flowing for 1500 years, have been drying up over the past 15 years along with the dissolution of community cooperation related to them (Wessels & Hoovghan, 2002). It can be said that a proper eco-friendly system has been replaced with the new hydraulic technologies which are "heavy energy users", require government subsidies and degrade the environment (Majd, 2000). In effect, the first group's opinion, which was mentioned before, has prevailed since the 1960s. Although water production increased considerably, lots of Qanats have dried up and this has resulted in many environmental and socio-economic problems.

General Social impacts of the Land Reform Law and the modern cooperatives

Rural reforms have rarely proved successful in the Third world (Ghaffary, 2006). Iran's land reform program wasn't an exception as well and it has had many catastrophic impacts due to the lack of understanding of the local context by both foreign and new domestic agents (Balali, 2009). Because of the rapid fragmentation

and disintegration of the pre-capitalist collective organization of Boneh, sharecropping also gave way to the individualistic arrangements of smallholding. The new system turned the peasants into small owners with no ethics to cooperate with one another (Balali, 2009). In rural regions, whoever had the right to work on the lord's land could profit from the land reform program by taking ownership of a part of the same land, and the rest of the villagers had no choice but to migrate to the principal cities (Kuros and Khaneiki, 2007). In other words, apart from farmer families who received land, there was an increase in the number of landless peasants as a result of the land reform law. This group constituted the poor migrant population of the big cities (Bonine, 2003: 223). Moreover, a drastic decline in the landowners' power and their managerial control was other consequence of the rapid fragmentation and disintegration of the Boneh system (Ajami, 1993). Eradicating the former lords' power made them invest in the industrial and commercial sectors while this decline deprived rural society of the services they provided before the land reform.

The United Nation's publication "Progress in Land Reform" was published in 1966 in the early stages of the land reform and creation of the modern governmental cooperatives. This report is deeply suspicious about the effectiveness of these cooperatives. According to the report, it is not clear that the formation of the new cooperatives have solved the social and political problems of landlord dominance. In addition, because Iranian farmers have little experience in egalitarian cooperation it is not apparent that the new cooperatives can provide "the organizational and physical services formerly provided by the landlords and their agents" (Keddie, 1968: 87). Based on the report, the sole function of many of these cooperatives is to enable the tenant recipients of redistributed land to formally conform to the requirements of the law (Keddie, 1968). The report sums up that it is obvious many of these organisations are cooperatives in name only (Keddie, 1968).

There were other criticisms of the rapid social institutionalisation after the land reform. A survey of rural cooperatives in 1975 revealed that, although 93 per cent of the new cooperatives conducted some consumer sales and 90 per cent extended loans to members, only 23 per cent were active in providing agricultural machinery and other inputs, and only 21 per cent had programs to buy the peasants' surplus production (Ajami, 1993). Hooglund was critical of the farm corporations, as he was

of the agribusinesses. His works indicate that the farm corporations did nothing for peasant welfare and were disastrous for peasant morale and created a sense of injustice (Hooglund, 1982). Based on his studies, the agribusinesses proved to be even less successful than the farm corporations (Hooglund, 1982). The multinational investors and managers of the agribusinesses were foreigners, unaware of the agricultural conditions in Iran (Hooglund, 1982). These large-scale, state-sponsored agricultural projects were evaluated as "expensive failures" of the land reform program by some other scholars (Bonine, 2001: 224). Both the agribusinesses and the farm corporations were a dismal failure for the reasons outlined by Hooglund; simply, because they were irrelevant to Iran's needs (Hooglund, 1982). So, "the failure of the cooperative societies to provide more than marginal benefits to the peasants was directly the result of government policy"(Hooglund, 1982: 46).

Generally speaking, although rural cooperatives had originally been designed to serve two to four villages each and despite the considerable financial and other resources devoted to the corporations, many deficiencies prevented them from expanding their activities beyond granting loans and marketing (Ajami, 1993; Hooglund, 1981). Since management of the new agricultural corporations consisted of trained civil servants appointed by the central government, most of them lacked qualified personnel and effective management. Furthermore, establishing these corporations instead of the Boneh system was a part of the government intervention (Hooglund, 1973: 233). Accordingly, the new cooperatives were not allowed to develop into truly autonomous institutions; rather, they became agencies of the central government (Hooglund, 1982). In theory, a cooperative was to be formed in every village where land was to be transferred to the peasants, but in practice that was not possible. Membership in the cooperatives was originally limited to peasants holding ploughlands (Ajami, 1993). Under the land reform law, membership in the appropriate village cooperative was a precondition for receiving land (Ajami, 1993). In effect, the real function of membership in the new cooperatives, instead of collective agricultural work, was respecting institutional formalities of the land reform program to receive lands from the government. Beyond this role, they were not working effectively. On a long-term basis, peasants were not given access to better knowledge and techniques for using land and water (Hooglund, 1982). Thus, there was always a great need for increased government services (Keddie, 1963). The above situation indicates that peasants did

not appreciate the opportunity to become part of farm corporations (Hooglund, 1973). Ultimately, no village level institution has ever taken over the functions of Boneh (Balali, 2009).

Negative impacts of the Land Reform Law on water management

As described above, despite some early warnings (Keddie, 1963; Hooglund, 1973; UN's Progress Report; 1968), the land reform law was carried out without consideration for the complicated relationships among the production systems, environment and water management in Iran. The most significant effect of the redistribution of agricultural lands was on water management systems in Iran (Farshad and Zinck, 1998). These water-related negative impacts mostly originated from destruction of the Qanat-Boneh system. In this regard, it has been said that the "extremely functional traditional institutions" of Boneh and Qanat were destroyed in the name of Western-oriented modernization (William, 2003). This means that the indigenous knowledge acquired through the Boneh system was neither used by nor transferred to the new generations (Balali, 2009). The traditional sense of land and water resources management for the benefit of the community seems to be giving way to an 'every man for himself' mentality (Balali, 2009) and an individualistic smallholding pattern. The final consequence of the lose of traditional water management functions has been the decline of irrigation efficiency in rural areas (Kuros and Khaneiki, 2007; Balali, 2009). This decline was the result of some specific causes.

The first cause was dependency on governmental services. Before land reform, the utilization of water resources had been governed by a complex body of traditional and local customs (Balali, 2009). In the traditional system of Boneh, large land owners were able to retain the best land with the best access to fresh water and irrigation facilities. In contrast, not only were the new peasant land holdings too small to produce an income but the peasants also lacked both quality irrigation system and sustained government support to enable them to develop their land to make a reasonable living (Amid, 1990). This means that after the eradication of the Boneh system and the replacement of landlords with government agencies, rural people were

no longer able to collectively maintain rural infrastructure. Then, villagers became dependent on the state for the necessary services, but the government was not able to supply all of these needs effectively. As the responsibility for mobilizing, treating, distributing and protecting water became a problem for the central governmental system of water management, this new water management alienated people from the source of supply.

The second reason was the overuse of deep well technology. After the land reform law was enforced and the lords' lands were distributed among the farmers, the land holdings given to the peasants were too small and fragmented to maintain the Qanats. As a result, so many landowners and farmers preferred pumped wells and allowed their Qanats to languish. In addition to the privately owned and constructed wells, the public sector was now engaged in the construction of many modern hydraulic projects such as large-scale dams (Balali, 2009). The pumped wells were drilled one after another and many pumps began sucking up the ground water resources. In villages, whoever had a better financial ability did not hesitate to drill a deep well which over-extracted the water many other people were entitled to. Finally, the depletion of groundwater by deep wells meant that many Qanats fell into decay (Kuros and Khaneiki, 2007). As mentioned earlier, according to the land reform law, the lords were forced to sell their lands to the government, but mechanized farms that had pump extraction were legally exempted. Accordingly, some of the lords were encouraged to replace the Qanat with pump extraction to save their own lands. The lords hurried to dig the well with extractive pumps to avoid being included in the land reform law, even if their lands needed no well. In doing so, the number of deep wells began to increase significantly (Kuros and Khaneiki, 2007). As this study indicates later, owning private deep wells is one of the main obstacles to establishing irrigators' associations and other forms of collective action for water issues in rural areas.

The third reason for water inefficiency includes migration of Qanat practitioners. Since the Land Reform Law did not bring any profit to the Qanat practitioners, it made them leave the agricultural areas. As mentioned in the previous chapter, the rural society before the land reform was divided into two general castes: locally named sharecroppers (*Nasaqdar*) and landless agricultural labourers (*Khoshneshin*). Sharecropper (*Nasaqdar*) were the groups who had the right to work for the lord as

his farmers on his fields; so, they had priority over the second caste (*Khoshneshin*) whose jobs were less related to the agricultural activities. Landless peasants would mostly provide other needs of the rural community such as masonry, carpentry, handicrafts and the Qanat-related activities. Before the land reform, whoever worked in an agricultural unit (Boneh) was responsible for just a particular job such as plowing; seeding, irrigating or harvesting, and the farmers rarely interfered with one another's job. Therefore, each farmer could not be so good at all jobs and only irrigators and Qanat practitioners were capable of irrigating the fields and preserving Qanats. In other words, Qanat practitioners comprised a professional community but, according to the traditional class structure, they did not have the right to work on the lord's lands as some permanent farmers had (Balali, 2009). Meanwhile, by the land reform law, the lord's lands should have been distributed just among the sharecroppers (*Nasaqdars*), the people who worked on the lord's fields. In this way, Qanat practitioners could no longer work for any lord who used to finance the Qanat and give them an opportunity to earn a living. Therefore, Qanat practitioners were encouraged to migrate to the cities. Finally, the competition among irrigators for higher position in the Boneh was over (Kuros and Khaneiki, 2007). In the absence of the Qanat practitioners, unskilled people in irrigation practices wasted a large proportion of water in many ways. Consumption of water increased, and the demand for water quickly surpassed the supply of Qanats. To sum up the third reason of the irrigation inefficiency, the land reform greatly raised a demand for irrigation because of water mismanagement by unspecialised people and land fragmentation (Balali, 2009). At the same time, the above circumstances forced Qanat practitioners to leave agricultural areas. Therefore, due to a lack of Qanat experts, the farmers had to drill deep wells to pump the aquifer for providing the required water (Balali, 2009).

Agricultural policies and institutional measures after the 1979 Revolution

Iran's agricultural sector and rural society were gradually marginalised following the 1962 land reform. Because of the active government intervention in the traditional agricultural sector (Hooglund, 1982; 1981; 1973) and the low priority given to the scattered populations in rural areas (Ghaffari, 2006), there was a decline in the agricultural sector before the Iranian revolution of 1979. Moreover, the sudden surge

in oil revenue in 1974 which resulted in the increasing "petrolisation of the national economy" (Ehsani, 2006: 84) enabled Iran to neglect its rural and agriculture sector. This meant peasants who had lost the support of landlords since the land reform, were losing the government's attention as well. Therefore, many peasants who could not survive on their small holdings moved to the cities in search of work. This migration led to the depopulation of the countryside and the creation of a vast and unsatisfied urban proletariat (Balali, 2009). This deterioration of the agricultural sector and disastrous results of the foreign agribusiness schemes, were used by the Shah's opponents as a major criticism and was one of the contributing causes of the 1979 Revolution (Bonine, 2003). Therefore, the revitalization of the agricultural sector became one of the most serious economic promises of the new regime after the 1979 revolution (Hooglund, 1973). The post-revolutionary rural policies and their impacts on rural life have received comparatively little attention (Ghaffari, 2006); so, many further studies are required in this particular field. As some current studies indicate, the post-revolutionary reforms led to the survival of medium-sized commercial farmers and to the fall of the large agricultural bourgeoisie. This bourgeoisie was created by the fall of the old land-owning class before the 1979 revolution (Ghaffari, 2006). After the revolution 1979, traditional agriculture and irrigation methods received renewed support in addition to the rebuilding and maintenance of some Qanat systems (Bonine, 2003). Moreover, reorganisation of the pre-revolutionary agricultural administration, the establishment of a revolutionary organisation for rural development (the Agricultural Jihad) were among the main measures taken by the post-revolution government in Iran (Ghaffari, 2006).

Following the post-revolutionary rural institutionalisations, different rural institutions were formed in the early years after the 1979 Revolution. Due to the revolutionary socio-political conditions, parts of the previously agricultural capitalist enterprises were dissolved and some new organisations were formed (Balal, 2009; Ghaffari, 2006). *Mosha*, which has emerged as a result of the revolutionary measures, was one of the most important agricultural organisations in the early years following the revolution. *Mosha* was a new collective ownership of agricultural land and a new mode of agriculture production. This new joint productive cooperative is a society of peasants (usually between 5 and 15 peasants) who jointly own a piece of land and work in partnership. They cultivate the land according to the plans of the state

agriculture and priorities. *Mosha* or the joint productive cooperatives had three potentialities: 1) land which is a sum of all the members' shares; 2) water resources, all the costs of which should be paid by members; and 3) agricultural machinery which all members can equally use (Balali, 2009). But after all the reorganisations, two main strategies towards sustainable land and water use dominated the efforts of the Ministry of Agriculture to achieve agricultural development and increase production. First is land consolidation as a way of coping with the issue of smallholding and for arranging farmers' participation in rural projects, and the second is creating Agricultural Production Cooperatives (APCs) (Ibid).

Current institutional arrangements in rural areas

After the socio-political changes brought about by the land reform, private ownership and smallholding became the dominant land use pattern and the majority of farmers (76.9 %) became owners of their land. This individualistic system has been criticised because according to the smallholding pattern every farm needs separate equipment for land preparation, sowing, harvesting and irrigation (Balali, 2009). To overcome the shortcomings of the smallholding system, the postrevolutionary government tried to promote some measures like land consolidation and new participatory rural institutions (Ibid). Today, there are different kinds of rural institutions in the villages which can be categorised at least into two groups. The first group organisations are directed towards agriculture production such as the Agricultural Production Cooperatives (APCs), rural production Cooperative, *Mosha* cooperatives, and industrial farm and irrigators' association. The second group of rural organisations, like the Village Council, are directed towards the public sphere of a village (general cultural and socio-economic issues). Among the Agricultural Production Cooperatives (APCs), the "rural production cooperative" is the major one in the Iranian villages and many farmers are member of this modern cooperative (Ibid).

A study based on the semi-structured interviews in 2009 by Balali investigated the attitudes of relevant stakeholders such as farmers and villagers about sustainability, technology and participation (Balali, 2009: 47). This empirical investigation was carried out by interviewing 156 Iranian farmers from 40 villages which were chosen

among 14 provinces out of 31 provinces around the country. The results of this study can be useful for arriving at a general picture of current institutional situation in rural areas. Based on this study, 22.9 per cent of informants stated that traditional cooperative systems were still in operation in their villages. In some villages, there were traditional participatory and collective practices such as land preparation and cultivation, irrigation and harvesting, cleaning of water canals and Qanat, and distribution of water that a minority of famers still perform. The majority of farmers are familiar with land consolidation but disagreement among the farmers and distrust of governmental agencies prevent them from participating in land consolidation. According to the respondents, there are several kinds of rural institutions in 45.2 % of villages. The Agricultural Production Cooperatives (APCs) and the rural production cooperative are the most widespread of these institutions. Informants and farmers who are not members of any rural institutions argue that the absence of a rural production cooperative in the village is the result of lack of information about the importance of rural production cooperatives, lack of enough guidance by government, lack of farmers' enthusiasm for collective actions, farmers' preference for independent working and dissatisfaction with rural cooperatives. Also, informants mentioned lack of a need for cooperation because of individual/private deep wells as the main reason for the absence of an irrigators' association in their villages (Ibid).

The farmers' attitude was more positive about rural production cooperatives, the village council and the change of collective and participatory action compared to 20 years ago. In general, farmers and informants believed that the government's measures for participation and providing opportunities for people to participate in the rural projects have moderately increased. The informants were moderately positive about rural people's participation in land and water projects. They mentioned 35 kinds of projects, in which local people participated according to their capabilities. Informants' activities in these projects included payment of project costs, voluntary work in the project as a labourer, and partly by giving their land and some other means and facilities for the projects. Although individual practice related to water management is growing, but informants believed that people still shared the protection costs of water resources by paying administrative fees and that they also engage in cooperative activities regarding the management of water resources. But in the final analysis of the interview results, informants were not very optimistic about

the general efficiency of rural institutions. They believed the disadvantages of these institutions outweighed their advantages. The informants thought that the formulation of projects was top-down and people's role in identifying processes was low. This prevented rural people from participating in the implementation of those projects. Regarding the interview outcomes, to enhance the efficiency of the projects performance, local groups should be included in the process right from the start (Ibid).

Furthermore, a recent study by Karami and Rezaei-Moghaddam (2005) on Agricultural Production Cooperatives (APCs) from 1975 till 2000 around the country also confirmed peasants' relative pessimism about rural institutions. Considering this study, APCs were unsuccessful in achieving land consolidation and group work. Researchers have argued that the new post-revolutionary APCs also are not successful because of their rapid expansion and because the government has not been able to provide much support and leadership to them (Balali, 2009). Due to this expansion, the government has proved incapable of providing the new cooperatives with adequate resources, without which they cannot function (Ghaffari, 2006). Accordingly, many peasants are not interested in cooperatives, from which they do not expect to receive any concrete benefits (Balali, 2009).

Chapter Conclusions

In this chapter, I have attempted to explain a water paradigm shift within the context of Iran's social revolution during the 1960s. I have evaluated the technologies and social institutions created by this social revolution and their unsuccessful attempts to replace the Qanat system. Iran's White Revolution of 1960s shapes the wider social context of the modern water paradigm in contemporary Iran. The most crucial aspect of the former Iranian regime's White revolution was the Land Reform Law. Land fragmentation/smallholding and the decline of the landowner's managerial control were some consequences of this reform. Beside the general negative impacts, the land reform has also had some specific water-related catastrophic results. One of them was a boom in the numbers of the pumped wells which made more Qanats cease functioning each year (Farshad and Zink, 1997). Furthermore, demise of the Boneh system was the most dramatic social impact of this land reform. Then, the rural area

has experienced different kinds of cooperative systems which are the modern alternatives of Bonehs. None of the modern cooperatives were as successful as the Boneh system in organising collective action (Ehsani, 2006). After the 1979 Revolution, post-revolutionary rural policies were reactions to the negligence of the former Iranian government about agricultural and rural issues. Due to the strategy of the Ministry of Agriculture for establishing new Agricultural Production Cooperatives (APCs) after 1996, farmers have become more positive towards rural production cooperatives. They generally have a positive attitude to the role of government in improving farmer participation in rural issues compared to 20 years ago. This can be seen as a result of the emergence of the integrated water management paradigm. Introduction of the Village Council has caused a relative improvement in the role of government to facilitate the rural population's participation compared to the last decades. But despite these socio-political changes after the 1979 Revolution, the majority of locals are not members of post-revolutionary cooperatives. Villagers' lack of interest in these cooperatives is due to disagreement among the farmers, deficient governmental leadership, distrust of governmental agencies, and farmers' dissatisfaction with the earlier rural cooperative system that was established after the land reform. Instead of including rural people from the beginning in the whole process, all the new cooperatives have been established by a top-down approach. This unilateral vision of organising cooperatives is the main challenge for arriving at a multi-stakeholder participation in a collective land and water management regimes. Agricultural Production Cooperatives (APCs) have been futile in achieving land consolidation and collective work, which were the main reasons for their establishment. Eventually, despite the proclaimed emphasis of the post-revolutionary government on rural development, the agricultural sector of the Iranian economy still remained ineffective (Balali, 2009; Ghaffari, 2006). To sum up, by losing the Boneh system as the social level of the traditional water paradigm in Iran, the agricultural sector and rural society have become the arena where various social engineering programs have been tried by new national and international players. Many of these schemes were left unfinished or abandoned with minimal participation from the rural population (Ehsani, 2006). None of the efforts before and after the 1979 Revolution succeeded in replacing the Qanat/Boneh system (Balali, 2009). All these factors together have led to separating the techno-physical aspects of water management from its associated social relationships. In other words, disconnection between technology

and its social context has been the final outcome of the modernisation process in water management.

In the next chapter, I describe all the conclusions resulting from the study of the Qanat system.

Chapter Six: Argument and Analysis

Chapter introduction

This chapter discusses the conclusions resulting from my study of traditional and modern water management in Iran. To present the Qanat-related conclusions, I apply the four-level framework and also I use the division framework, explained in chapter two, to compare the Qanat system with the modern water paradigm in Iran. In fact, this division is the outline of the information in the chapter four and five in the form of a traditional/modern distinction. Furthermore, the tension between traditional sustainability and modern egalitarianism/social justice will be explored as a consequence of feudalism/capitalism clash at the end of this chapter.

The Qanat-related conclusions: division of the Qanat system and its alternatives

Traditional water paradigm in Iran (first part of the division)

Traditional water management in Iran, in addition to the technical system, included a set of social and ritual practices and a property regime around Qanat. The pre-modern water paradigm in Iran can be characterised by the underground channels of Qanat as its key technical system, Boneh as its main governance and social institution, and some mythical-religious aspects. In this way, the Qanat system is a model of water consumers' technical, socio-institutional, ritual and financial engagement with water issues. These elements created the social cohesion of Qanat-watered villages in Iran. Throughout my thesis I have attempted to include some mythical and ritual dimensions which are embedded in the rites, such as Qanat marriage. This ceremony is an example of the ritual regulations within the Qanat system.

Unlike the physical structure of Qanat, Boneh has been widely unknown as a result of the separation of the Qanat system from its sociocultural context. While people are mostly familiar with the physical system of Qanat, because of sociocultural ignorance in Qanat studies and the dominant engineering discourses in the existing Qanat literature, even Iranians mostly have no idea what Boneh is. As was mentioned in chapter 4, even in the academic references regarding Qanat, there is no discussion of

Boneh. This lack of sociocultural awareness has been one of the most important shortcomings of Qanat studies. The shortage and sometimes lack of knowledge about the social-ritual-moral aspects of the Qanat system also is a result of over-emphasis on the quantitative and engineering discourses. This current quantitative and engineering discourse can be complemented by approaches such as TEK studies and qualitative methods within which the context is essential. Overcoming these separations in the case of Iranian ethnohydrology is the main promise of my study. For a holistic organisation of the elements, I followed Berkes's four-level framework through my study. This framework seems to be a suitable framework for presenting the conclusions as well.

At the socio-institutional level of Iranian ethnohydrology, Boneh is the most relevant social institution on which the Iranian villages before the Land Reform law depended. Boneh was the collective land and water management and ownership in pre-capitalist rural Iran. Centuries had passed until the rules of Boneh were settled down through local customs even in the most remote villages (Safinejad, 1989: 546). This system was the result of millennia of human adaptation to water scarcity and generations of trial and experimentation which has proven that villagers should share the management and ownership of water resources through a complex body of sharing ethics among local stakeholders. This ethic of sharing includes community members' obligation to share in the technical, socio-organisational and ritual practices of the water system. It also included a pattern for water distribution among different rural groups, plus an agrarian class structure. Meanwhile, the Qanat system has its own shortages as well. According to this traditional land and water ownership regime, landlords provided managerial and organisational services in agriculture and the water sector. Then, in return, as an upper social class they were given special rights. This meant that the social structure resulting from landlord dominance was discriminatory and in disagreement with the modern context and values. Nevertheless, water was treated as a common property in the old system within which the lord was responsible for Qanat maintenance. The locals' involvement in nearly all Qanat practices is the key point in regard to the success of traditional water management in Iran. To sum up, through this holistic system, community members had obligations to become involved, in different ways, in water management practices. Accordingly, the Qanat/Boneh system was successful in organising farmers for collective action on

water issues; albeit, along with equalities in dividing crops because of the hierarchy of Boneh.

At the intellectual level of the water systems, negligence about the mutual impacts of environmental perceptions and socio-technical systems of water management is another shortcoming of modern water paradigms. According to Durkheim's viewpoint, the only function of religion and rituals is to bind community through shared symbols (Lansing, 1991). The distinction made by Durkheimian notions and Eurocentric Western social theory between rituals and the material technology has been challenged in recent decades (Ibid). Including these neglected cognitive aspects of water management should be a part of every qualitative approach to water management. Myths and rituals at the intellectual level of TEK systems contain the most subjective, intellectual and qualitative aspect of these systems. All the water rites and associated beliefs in rural areas of the country create the intellectual level of Iranian ethnohydrology too. Among them, Qanat marriage is the chosen ceremony in my study. As the result of the ritual aspect of the Qanat system, the waters of Qanats were held as sacred and the protection and care of the system often involved ceremonial rites. Demanding grace from nature is the core purpose of this class of rituals, and in my case demanding more water or watermaking is the performers' and participants' final aim. Also, Qanat marriage ritual can be described as an intensification and fertility rite that includes many animistic beliefs. In other words, this ritual can be described as a fertility or intensification rite which is based on animistic beliefs.

The adaptive role of fertility or intensification rites in a community's relationships with its natural resources has been discussed in anthropological literature during the past few decades (Rappaport, 1984; Bates, 2003). As indicated by Rappaport, rituals could play a central role in the maintenance of a society's balance with its resources. Accordingly, Rappaport's argument about rituals' adaptive role is a useful analysis for clarifying the impact of Qanat marriage on the real world when we seek to discover how this water ceremony helps regulate the relationships of a given community with its water resources. Moreover, new animism theories investigate animistic beliefs and practices in terms of their impact on people-environment relationships. By attributing subjective meanings to natural resources, animists transform natural resources to

persons who respond to or initiate approaches to other humans. In addition, Georges Condominas's "Ritual technology" concept has been another relevant argument in indicating the role of rituals in human-environment relationships. As argued by Strang (2006), the diverse meanings and values attached to water for both providers and consumers deeply influences patterns of water use. According to Strang (2006), because these social constructs served to involve water users in resource management and create a sense of collective responsibility; thus, these constructs have ecologically sustainable impacts on water resources.

Using these arguments, one can see ritual as an integral element of traditional technology. I have tried to explain the technical-ecological dimensions of the Qanat system side by side with its socio-ritual aspects. Taking into account the fact that performers and participants of Qanat rituals are the same people who consume and manage Qanat's water, the regulatory role of Qanat marriage becomes more obvious. Qanat's water users and managers rather than personal participation in or performance of the Qanat marriage ceremony are expected to get involved in the ritual in the other ways. For example, they provide the costs of the ceremony or cover the Qanat's wife's living costs during the year. Since during times of water scarcity, peasants should personally or financially become involved in the ritual practices of Qanat, this Qanat ceremony can contribute to the local community's awareness about water limitations and supply difficulties. One can see that these animistic water beliefs lead to the idea of water as a limited resource; so, this awareness prevents water consumers from treating Qanat as an object of exploitation. The animistic/intensification/fertility rite of Qanat marriage prevents exploitative water use and the users' illusion of water abundance. Qanat marriage regulates respectful relationships with water resources as persons and the traditional water ethics - originated from this respectful view towards water - is the key point for a sustainable use of Qanat's water. Villagers' awareness of water scarcity in the traditional paradigm partly originates from the fact that due to the fluctuations of water resources consumers should have various forms of engagement in the Qanat ritual. The users' engagement in Qanat ritual can eliminate some perceptions inherited in the modern water paradigms such as the illusion of water abundance. Finally, respect and reciprocity toward water is the ultimate ethical outcome of attributing personhood to water in ceremonial practices of Qanat marriage.

Different levels of the modern water paradigm in Iran (second part of the division)

Agriculture in the dry areas of Iran has always been carried out through artificial irrigation; so, water management and its institutions always have been part of the wider agricultural structure. This rural structure formulates the social context within which Qanat technology functioned. Because of the importance of the sociocultural background of technology, I investigated the technical change of water management from Qanat to deep-wells as a part of the larger rural/agricultural transformation in Iran during the 1960s. The decisions about moving from traditional water management institutions towards a new regime have been made as a part of the general rural policies before and after the 1979 Revolution. The new paradigm of industrial modernity can be identified by the partial replacement of Qanats by deep wells and large dams (Balali, 2009), the replacement of the Boneh by a system of smallholding and modern rural cooperatives, and the emergence of a mechanistic worldview along with its associated ethical outcomes. On the other hand, the final goal behind the land reform of the 1960s was integrating the Iranian economy and its agricultural sector into global capitalism. The new value system according to which the land redistribution happened was basically driven by capitalism. Land reform officials promised a more egalitarian ownership law governing land and water resources by transferring ownership from lords to farmers and sharecroppers. In this way, land reform was actually a transformation from feudalism to capitalism. In the case of the water system, this transformation was a shift from feudalistic land and water law to an individualistic/capitalistic one. Moreover, Iran's integration into the global economy was supposed to happen through developing capitalistic agriculture in rural areas.

The primary goal of the land reforms in the 1960s was developing capitalistic production relations in the Third World's agriculture (Lahsaeizadeh, 2002). Multi-national corporations intended to invest in the agriculture section, but dominance of feudalistic relations in the Third World was the main obstacle to developing capitalism in Third World agriculture (Lahsaeizadeh, 2002). Subsequently, the

governments took over the responsibility of diminishing feudalism. By developing capitalistic agriculture, a huge class transformation resulted from land reform in Iran as well. In this way, rural people's relations with the means of production were changed by transferring ownership from lords to farmers. Government officials argued that the socio-political arrangement of landownership impeded economic development. The government declared that the land reform law was undertaken to solve the social and political problems of landlord dominance, but essentially the former Iranian government was more concerned about independent landlords' power and their control over rural life. This power resulted from the pre-capitalist property regime concerning land and water resources. Consequently, the government launched a radical institutional change which deeply impacted on the rural water sector as well. This shift caused the breakdown of the Boneh system, since lands were given to the sharecroppers not the institution of Boneh; consequently, Bonehs started to collapse (Lahsaeizadeh, 2002).

In the first phase during the 1960s, water management became subject to huge state intervention, and the indifferent bureaucracy's non-holistic approach alienated local water users from their resources. Establishment of new rural cooperatives, dam-building, and particularly modern electric and diesel-pumped wells (as the immediate alternative of Qanat's physical system) were all the consequences of Iran's land reform. But as this research shows, the techno-physical and social alternatives of the Qanat system along with the perceptual aspects of the new paradigm do not function effectively. Land reform officials claimed that new cooperatives could take over the role of landlords and Bonehs for production. But actually no rural organisation could do this (Lahsaeizadeh, 2002). "Those who wrote the land reform law drafts did not have any knowledge of the structure and function of Bonehs" (Lahsaeizadeh, 2002: 177). After the land reform and while the Bonehs were collapsing, some officials of the Ministry of Agriculture became familiar with the cohesive system of Boneh. Some authorities made failed attempts to revive Bonehs, but their efforts were futile because Boneh is based on water and commonality of the group which is using the same water resource (Safinejad, 1989: 546). This condition was not possible through the new individualistic arrangements.

As argued before, there are some internal correlations among all four levels of TEK systems. These inter-level feedbacks in my case caused the simultaneous disappearing of technical, social, and ritual dimensions of the Qanat system. At the technical level of this transformation, deep wells made it possible to extract more water in the short term. Farmers, as the main consumers of irrigation water in rural areas, were convinced that everybody could independently extract and use water without group work. But after a while many recognised the unsustainability of this method of water extraction and use. At the social level, by the land reform law and land redistribution, agricultural relationships shifted from the pre-capitalist model into the centralised model of national, international and private agencies. Direct government-sponsored measures created an individualistic model of water use by deep wells without collective action. Individualistic arrangements in land and water management resulted in individual irrigation of small farm fields and this individualism made peasants become small owners with no morale and enthusiasm for cooperative work.
The egalitarian cooperation and centralised governmental corporations failed to deliver the organisational and physical services which used to be provided by landlords and their agents. These government-established cooperatives could not create collective agricultural work since the individualistic management and property regime after Boneh was essentially in opposition to participatory practices.

Finally, peasants were not given water management services; meanwhile, private wells and irrigation by technically unskilled people led to more water mismanagement and irrigation inefficiency. At the intellectual level, the main perceptual aspect of the modern water paradigms which is disconnection with the social context can be identified in Iran's land reform process as well. At the intellectual level, animistic water beliefs, which used to play a regulatory role in the community's relations with its water resources, also ended during the process of water management modernisation. Under the influence of the objectivist modern paradigm, the spiritual meanings associated with the socio-technical system were ignored. Consequently, the rural population no longer regarded water resources as persons who should be carefully and respectfully treated. This idea that the modern techniques by the huge amount of extracted water can solve water management problems without consumers' collective work was the assumption behind this technology-centeredness.

My review of the causes and consequences of current water mismanagement in rural Iran indicates that the paradigm shift has experienced two rural/ agricultural formations: between the land reform and the 1979 Revolution and the post-revolutionary era. The 1979 change of regimes brought about by the Islamic revolution was a turning point in terms of rural institutionalisation. Oil revenue and industrialisation caused lack of attention to the agricultural sector and rural areas after the land reform law until 1979. This decline of the agriculture sector was one of the main criticisms about the Shah's pro-Western regime. In reaction, the post-revolutionary government considered rural development as one of its main priorities. Post-revolutionary rural institutions tried to promote participatory action among villagers in water management. But despite some relative improvements due to the establishment of village councils and the new Agricultural Production Cooperatives (APCs) in 1996, many shortages still prevent rural community's engagement in water projects and this causes the low level of collective practices in water management. Lack of farmers' enthusiasm for collective action, dissatisfaction with the former rural institutions before the revolution, the top-down way of organising water projects, deficient governmental leadership and distrust of government agencies are among the major shortages. Post-revolutionary rural institutions also are not efficient enough in terms of engaging rural people into water management. Finally, villagers are still pessimistic about rural institutions; consequently, individual water management practices are still the dominant pattern. This means despite some attempts at collective farming, the majority of villagers tend to perform individualistic cultivation (Safinejad, 1989).

To sum up the division of the Qanat system and its alternatives, it can be said that in the traditional water paradigm, community members had obligations to share in the technical, socio-organisational and ritual practices of the Qanat system. The villagers' collective responsibility resulted from their involvement in all Qanat practices. Modern technological advances in dam-building, well-drilling and pump technology made a dramatic increase in water production possible. Meanwhile, compared with Qanats, deep wells and their water use patterns are environmentally damaging and socially disconnecting. Private wells instead of a communal Qanat ownership regime developed a pattern of separate irrigation for small farm fields which made collective action impossible. According to many scholars, no institution could replace the

functions of the Boneh system. Instead of the participatory system of Qanat/Boneh, current organisational arrangements include individualistic use of water together with governmental cooperatives which have tried unsuccessfully to incorporate villagers into the collective agriculture and irrigation. While Boneh was a successful institution for attracting farmers' participation for water management over centuries, new rural institutions have been inefficient. Moreover, disappearance of local water beliefs and ceremonies has been other part of the same process of paradigm shift from the Qanat/Boneh relationships to the modern deep wells/cooperatives. Various rural policies before and after the 1979 Revolution and different types of modern cooperatives all proved to be unproductive in organising collective action because the essential institutional arrangements associated with the modern paradigm prevent collective water management. The majority of locals are not members of these rural institutions and individualistic extraction and use of groudwaters by deep wells is still the dominant pattern. The individualistic management and ownership of water has been the main obstacle for development of participatory water management (in particular, they prevent the establishment of irrigators' associations). Individualistic management and ownership of water keeps the rural population's participation at the lowest level which means the new system is a dysfunctional alternative to the Qanat/Boneh system. As can be seen, the government's vision to implement and manage irrigation projects has been exclusively orientated to the physical aspects; so, the participation of farmers or nongovernmental organizations has been neglected. The result of such a one-dimensional vision has been dissociation of cultural and social relations between farmers and their system of irrigation (Balali, 2009). By losing the social and ecological functions of the Qanat system, the same chaos of other Third World rural communities in water management can be identified in Iran. This breakdown of a holistic water paradigm is another example of a water paradigm which is technology-centred and uninformed of socio-cultural contexts of water technologies.

The tension between a sustainable unequal system and the modern system of egalitarian agriculture

A tension can be identified between two sides of the above division. This challenge can be described as a tension between environmental sustainability and modern social justice. As was explained in the previous chapters, sustainability was a merit of the

old feudalism; on the other hand, the modern values of the land reform law have been mostly requirements of a capitalistic agriculture. In pre-capitalist rural Iran, production relations were predominantly based on feudalism, although there were some other marginal formations, but feudalism was the dominant socio-economic formation in Iranian villages. The main form of land ownership was ownership over a whole village and sharecropping was the main form of relationship between farmers and landlords (Lahsaeizadeh, 2002). All the resources of a given village were divided among Bonehs of that village (Lahsaeizadeh, 2002) and Boneh was one of the major institutions of this feudalistic order. To sum up the fundamental characteristic of Boneh, it can be said that this system required working under supervision of the highest member of an agricultural unit, on common land using the same water resource belonging to a landlord. There are many controversies around political economy, the concept of feudalism, capitalism, relations of production and the way Marxism has used them. However, the specific tension under my investigation originates from the clash between feudalism and capitalism. Thus, we can conclude that the clash between global capitalism and Iran's feudalism is the broadest context of the land reform of the 1960s. Consequently, by investigating this clash my research has attempted to apply the contextual analysis of qualitative research to the study of land reform and its resulting tensions.

There were some disadvantages in the old land and water system which paved way for the land reform of the 1960s. The hierarchies of the Qanat/Boneh system were parts of the feudalistic ownership law in rural Iran. The old ownership regime was not based on the equal ownership on water resources (Qanat's water). Landlords owned lands and water resources (Qanats) of a given village; in return, they provided managerial and supervisory services. Farmers were working under landlords' unifying management in each village. Although Boneh was one of the best ways of using land and water for collective production (Safinejad, 1989: 14), those on the top of Boneh had privileges over other members. Generally, there were two main disadvantages about the Qanat/Boneh system. First, there was a low level of water production (water volume) in terms of industrial demands. This aspect is related to the techno-physical and water engineering viewpoints. Arguing about industrial growth is beyond the scope of my project; consequently, it cannot be the focus of my investigation. The second disadvantage is the exploitative dimensions of Iran's feudalism which resulted

in some social inequalities associated with the old system. This second deficiency is more social scientific; therefore I have attempted to explore it through my thesis. There were two types of social inequality in the feudalistic system: first, landlords' ownership over land and water resources; and second, unequal division of labour and product among Boneh members (Lahsaeizadeh, 2002). Regarding the first social inequality, it has been said that land and water were the services that landlords offered (Lahsaeizadeh, 2002). Accordingly, ownership over these two essential factors has put landlords in an exploitative position (Lahsaeizadeh, 2002) in the way that the dominant group of landlords permanently wanted to exploit the lower classes (Lahsaeizadeh, 2002). For example, peasants were likely to lose their sharecropping right due to disobeying the landlords' orders. As a result, the contrast between lord and vassal was the main conflict in rural areas before land reform (Lahsaeizadeh, 2002). Inequality in the division of labour led to the circumstances under which "the heaviest jobs were allocated to the lowest members of Boneh and the lightest work was awarded to the highest member" (Safinejad, 1989: 546). The social injustice problem in the Qanat system led to the tension between modern values such as social justice and water sustainability which was a consequence of the old Qanat/Boneh system.

These hierarchal disadvantages of feudalism profoundly contrast with the modern land and water ownership which was inspired by capitalism. This hierarchal injustice encouraged the Iranian government and its foreign advisers to implement the land reform of the 1960s to change the whole rural society of Iran. In response to the claimed physical and social disadvantages of the old system, land reform was supposed to be a shift towards more egalitarian land and water ownership. But as this research has shown, this transformation was based on many incorrect assumptions about advantages and disadvantages of the old and modern agricultural systems. Although the old system had some injustice, careful analysis shows that the physical and social deficiencies of the Qanat/Boneh system have been exaggerated. Despite inequalities, the weak members of Boneh gained a minimum livelihood and were protected from financial and security risks. Due to this minimum living, the situation hardly ever has resulted in peasant uprisings (Lahsaeizadeh, 2002). Furthermore, peasant's job promotion in the hierarchy of Bonehs was possible. This means that peasants, by upgrading to higher positions, could obtain a larger share of agricultural

products. Also, a careful study of the modernisation of the water system in Iran demonstrates many deficiencies in the new system. As was argued before, the concept of social equality which was claimed by the new system was inspired by global capitalism. Furthermore, regarding the internal legitimacy of the land reform, this change was mostly supported by pro-Western urban intellectuals not the peasants themselves (Lahsaeizadeh, 2002: 142). Thus, the equality promised by the officials of the land reform program was actually a class structure needed by Western capitalism and was not that egalitarian in action. Accordingly, the new system produced new inequalities of its own. For instance, the land reform formed a dominant class in villages which intended accumulating more land as much as possible. Also, these reforms allowed some groups with special status in villages to invest increasingly in rural areas (Lahsaeizadeh, 2002). The goal of land reform was the demise of landlords as a socio-economic class but after the reform some of the landlords or their representatives became agricultural capitalists and lands were distributed unequally as well (Lahsaeizadeh, 2002). Furthermore, during the process of developing new peasantry classes, many villagers became rural labourers whom the new rural economy could not employ. Consequently, the only solution for a big proportion of these people was migration to cities. This fact indicates that many of the lower members of Bonehs were not able to adapt to the new conditions after the collapse of Boneh (Lahsaeizadeh, 2002). As can be seen, the development of capitalism in Iran's agricultural sector mostly benefited the Western economy (Lahsaeizadeh, 2002: 112). Traditional social inequality was mainly a justification for the land reform law and the new system brought new forms of exploitation and domination.

Finally, the conflict of traditional water sustainability and modern social justice in the case of the Qanat system and its alternatives can be summarised based on the different economic infrastructures of two systems. In this way, the water paradigm shift in Iran has been a transformation from feudalistic land and water law to individualistic/capitalistic arrangements. One can see that despite some abusive dimensions in the old system, it had many positive points as well. Furthermore, the new system of egalitarian agriculture was not actually very equal. While the new system diminished the old environmental sustainability, it could not create an egalitarian agriculture.

Chapter conclusion

This chapter discussed the conclusions about the traditional and modern water management systems in Iran. These results were presented in the form of a division between the levels of the Qanat system and its modern alternatives. This division, by the use of data from the previous chapters, summarised the levels of the Qanat system, transition process, and the levels of the modern paradigm of water management in Iran. In addition, the tension between water sustainability in the old feudalistic system and some values of modern capitalism was recognised and discussed.

In the next chapter, I will use the case-related conclusions of the current chapter to extract a worldwide division between traditional and modern water paradigms.

Chapter seven: general conclusions

Chapter introduction

In chapter seven, I use the arguments and conclusions related to the specific cases of this study to develop a broader division between the traditional and Western-oriented water paradigms. Again, I categorise the characteristics of each paradigm according to Berkes's four-level framework. My goal is to indicate how the water paradigm shift at a global scale created a universal challenge during the twentieth century. This division reveals that the Western-oriented water paradigm has caused certain negative environmental and social impacts resulting from unfit and exploitative elements at the all levels. On the contrary, local-based models, by integrating a set of eco-friendly values and practices, could have prevented many of these abusive attitudes towards water resources.

A worldwide division between traditional and modern water paradigms

The water crisis is a management crisis that has been created by the ways the modern paradigms mismanage water. This mismanagement acts through unsustainable technologies, dysfunctional institutions, and exploitative beliefs towards water resources. The exploitative assumptions behind water mismanagement are similar across the world and influential in the collapse of the old holistic systems. These sets of modern elements are alternatives to the four levels of traditional water systems. Traditional paradigms include environmentally friendly technologies, successful institutions at organising collective work and respectful-spiritual views towards water. These can successfully govern the resources used by many individuals in common. The core lesson of ethnoecology is that in addition to the technical aspect there is a sociocultural context attached to every resource management system. This context includes: symbolic meanings, cosmology, spiritual conceptualisation of the environment and communal institutions based on shared knowledge and meaning. As previous discussions have shown, technological aspects of water management should not be separated from beliefs, rituals and local cooperation systems. As a result,

ethnoecology or TEK studies investigate cultural, legal and technical practices of a water management system as a whole. The present research has attempted to demonstrate the importance of this integration and unity in the Iranian case and then has explained the contest between the traditional and modern paradigms of water management in the country. Traditional water paradigms regulate sustainable human-environment relationships by a set of eco-friendly practices and values; therefore, they have "moral solutions" for the current water crisis in addition to their promising technical aspects.

As stated in the second chapter, TEK can have two different meanings. TEK studies is a field related to anthropology for investigating traditional NRM systems. Also, TEK means the actual management systems themselves. So, in regard to the main characteristics of TEK studies as an anthropological approach one can see holism, comparativeness and complementarity with the Western resource management, and qualitativeness. The main point of ethnoecological holism is that because traditional water systems perform technical water management side by side with the relevant local cooperation, rituals and ceremonies, myths and spiritual beliefs, all of these elements should be investigated simultaneously. Despite modern paradigms of water management, TEK studie investigates water management as an integrated knowledge-practice-belief complex. TEK studies have developed various frameworks and strategies such as the four-level analysis to include many neglected elements of management systems. Also, this four-level framework is useful for studying the internal dynamics or inter-level feedbacks among these connected layers of TEK. For this purpose, technical and socio-institutional levels are investigated as praxis or two coupled elements. Ethnoecological comparativeness connotes comparative analysis of case studies. Complementarity with the Western resource management means TEK is not a total replacement for modern natural resource management but suggests that both systems should develop a joint-management model instead of removing each other. TEK is an approach which investigates water management as "an integrated system of belief and practice" (Posey, 2002: 60).

"TEK [studies] is qualitative" (Berkes, 1993: 4). Qualitativeness is a feature of TEK at the intellectual level. Concerning the application of qualitative concepts, first we should consider what does being qualitative mean for TEK studies? In other words,

what are the links between the qualitative characteristic of TEK studies and the general qualitative research methods in social science disciplines? Qualitative researchers try to cover more variables in addition to just objective and etic dimensions. Qualitative research can be more emic, case-based and closer to the actors' subjective perspectives; thus, this approach has developed techniques and concepts such as contextual and interpretive analysis that investigate subjective dimensions of social phenomena. At the same time, traditional water management also covers a large number of non-technical, context-related and subjective dimensions that are not capable of being measured by the dominant engineering and technical discourses of water management. Therefore, qualitative research is compatible with the holistic nature of traditional water management. This fact means that some additional qualitative concepts outside TEK literature can be integrated into the ethnoecological projects. Contextual analysis for studying the socio-technical level and interpretive approach for the intellectual level of water systems are among the appropriate tools in the wider qualitative research. Given the fact that there is a socio-perceptual context attached to the technological aspect of water systems, qualitative contextual analysis can contribute to understanding water management as a part of the larger social context and as a socio-cultural phenomena. These additional qualitative methods are helpful in overcoming the socio-cultural ignorance of modern water management.

Based on my study of the Qanat system and similar studies of other ethohydrological cases across the world, a division can be developed to clarify the contest between traditional and Western-oriented water systems. Modern counterparts of each element of traditional paradigm are supposed to have the same purpose. The division indicates how every inappropriate element at each level of modern water management has negative impacts on an environment. On the other side, the division model can show the ways in which inappropriate perceptual and social features of the modern paradigm may be prevented in traditional water systems. Each paradigm can be characterised by its key technical system, its main social institution and its perceptual framework.

Traditional paradigm: first part of the worldwide division

At the level of taxonomy and terminology (level 1), a typical traditional water paradigm as a type of TEK is a system of native terms and categories (corpus) regarding water and is generated by local resource users themselves not Western-orientated outsiders. At the technical level, the techno-physical system of ethnohydrology is not ecologically destructive; in other words, it is sustainable. This technical level of traditional water management is bound up in a complex web of institutional relations (Healy in Williams, 1993: 22). At the socio-organisational level, traditional water institutions had been well crafted to fit local circumstances and were successful at organising collective work. The unification of water manager and consumer at the institutional level led to consumers' high socio-physical engagement with water problems. Nevertheless, there are is considerable discrimination within TEK systems. Hierarchal social stratification is one of the most serious ones. Despite this major shortcoming, the two coupled levels of a TEK system (socio-technical levels or praxis) can lead to direct and cooperative human contact with the natural resources.

Regarding the intellectual level of the ethnohydrological systems, ecologically-orientated anthropologists have begun to understand the environmental functions of the neglected cognitive/intellectual aspects of natural resources management. TEK researchers' emphasis on the conception of nature as a sacred place helps to maintain some sort of equilibrium during production and natural use process which absence of such a conception puts producers at the high risk of destroying their material sources (Bicker, 2004). In this regard, Rappaport's principle about the regulatory impact of beliefs and rituals and Georges Condominas's concept of "Ritual technology" (Lansing, 1991: 122) are widely accepted in this field. The above principles challenge the Durkheimian notion about religion and rituals and generally the distinction made by Eurocentric Western social theory between rituals and the material technology (Lansing, 1991). While it is still difficult to indicate how indigenous animistic beliefs and rituals establish human-environment relationships, attempts have been made to correlate ritual cycles with natural seasonality in various parts of the world. "The natural ritual cycle" concept has been used by some scholars to explain the links between traditional perceptions and values and natural resource management (Posey,

2002: 79). In this way, cycles of rituals and ceremonies have been shown to function as regulators of natural resources (Lansing, 1991; Posey, 2002). Hence, traditional water beliefs and value systems have unintended conservational consequences; so, indigenous people have been called "conservation minded" (Healy in Williams, 1993: 22). Ultimately, eco-friendly socio-technical practices at the second and third level of TEK systems, in company with some traditional perceptions, clearly can maintain sustainability within an ecosystem. The final outcome of the intellectual level of local water management is careful-respectful-spiritual treatment towards water. As a result of the community's awareness about water fluctuations and limitations, this final outcome can play some conservational roles such as saving water. Ultimately, water gets more attention and receives more sustainable treatment in ethnohydrological systems compared to the contemporary water management.

Advantages and disadvantages of TEK systems

The unification of water manager and consumer is the important advantage of traditional water management at the institutional level. This unification leads to direct human contact with natural resources. Furthermore, disregarding exceptions, traditional water management systems by explicitly conservatory practices have resulted in a situation where human use of water resources had not led to devastation of the resources. Accordingly, valuable resources are exploited on a sustainable basis. Nevertheless, for a balanced assessment of two traditional and modern systems and any kind of ethnohydrology applications to a contemporary context we need to take into account some critiques of TEK systems. As mentioned before, the existing studies about traditional water systems across the world have not paid attention to these negative aspects of TEK systems. These criticisms indicate some false notions within TEK literature and some disadvantages of traditional systems. First of all, there have been some cases of traditional resource misuse, although not many compared with the modern alternatives. Furthermore, excessive claims of indigenous wisdom and stereotypes of indigenous communities as people whose traditions are always eco-efficient are all consequences of uncritical appreciation of TEK. Inequality and discriminatory social stratification within TEK systems is maybe the major disadvantage of traditional systems from a modern viewpoint. This stratification

includes hierarchal arrangement of community members into divisions according to which upper castes are entitled to privileged rights (Mosse, 2010). As was explained in the fourth chapter, this inequality in the case of Qanat includes the unequal division of labour and product between dominant landlords and dominated farmers of the Boneh system. Considering critiques of TEK, lack of attention to the shortcomings of ethnoecology and TEK systems can lead to some misapplications into the modern contexts. TEK disadvantages are mostly absent in the traditional water management case studies. The authors have not considered the criticisms of TEK; therefore, their work can be the basis of misjudgement.

Modern water paradigm as the second part of the universal division

Each element in the traditional paradigm has a modern counterpart; they are supposed to have the same purpose as the traditional paradigm elements. At the technical level, the physical structure of modern water management has created an oversupply of water in the short term. But in the long term, these unsustainable technologies put consumers at high risk of destroying their material sources. In brief, the physical structure of modern water systems by artificial oversupply of water conceals limitations of this natural resource. At the social level, we can see a lack of "common ground" (Strang, 1997) among stakeholders as one of the main features. This means the ecological effects of water usage and management are perceptually and physically distant from decision-makers; in brief, the social impact of modern management is that the participants have neither physical nor social "common ground" (Strang, 2006 and 1997). Moreover, the individualistic pattern of "every man for himself" (Harding, 1968) results in self-interested individual decisions. One can see that water management modernisation has mostly been a process of delocalisation and centralisation of water management (Strang, 2006). This centralised model develops water practices that are dictated by somebody else who is a non-local agent (mostly a government). The manager is a central government distant from natural resources; consequently, away from environmental impacts of its practices. Moreover, unfit organisations for local conditions are also parts of this organisational framework. Modern socio-technical arrangements provide easy and permanent physical access to water. Accordingly, the modern paradigm does not engage consumers with water

issues except in water consumption. This minimum socio-physical engagement with water leads to the invisibility of water scarcity. The set of participatory socio-technical practices in the traditional paradigm could prevent the illusion of water abundance. But due to the lack of these practices in the modern water paradigms, the waist of water has been one of the significant outcomes of modern viewpoints towards water.

A review of the characteristics of the modern water paradigm at the intellectual level shows that contemporary water systems are focused on physical water disconnected from its contexts (both water-related and non-water-related). The modern water paradigm is technology-centred. This factor causes ignorance about the socio-cultural context of technology. In other words, physical technologies associated with water have been isolated from other variables in the modern paradigm. Hence, because of the assumption of water management as a technical issue, modern water management can be called a reductionist paradigm as well. This concentration on technology means social institutions responsible for natural resources management have been disregarded in the dominant engineering discourse. Another characteristic of this paradigm is users' alienation from their water resources which comes from the perceptual disconnectedness between water users and their resources (Strang, 2006). The reason is that decision-makers and the ecological effects of water usage and management model are perceptually and physically distant. The modern paradigm is also exploitative and economic-minded**.** It regards water resources as objects of exploitation and is mostly concerned with the economic benefits of water. This paradigm includes many environmental perceptions, each of which plays a role in the waste of water which is the final outcome of these perceptions. After the breakdown of the holistic social, technological and environmental systems across the world the same ideas can be recognised behind all the water mismanagement. Users' illusion of water abundance is one of the most important elements arising from the invisibility of water scarcity. Under the influence of this illusion, consumers assume that water can be endlessly oversupplied. Due to the artificial oversupply and minimum involvement between water users and water resources, natural fluctuations of water resources are hidden in this model. Therefore, water's existence is divorced from the elements and the seasons. This paradigm is dominated by quantitative discourses. Consequently, it

is unable to cover different variables of water management and it has to decrease the number and area of its investigation to the technical issues. It is concentrated on the most quantitative variable which is the physical system of water management detached from social contexts. Finally, the modern water paradigm is objectivist. It makes water stakeholders ignore the subjective perspectives and the meanings that people attribute to their practices and environment.

Water management is as much socio-cultural as it is technical. Accordingly, water mismanagement is a social problem and the consequence of dysfunctional institutionalisation rather than a technical problem. Water crises, in addition to technical solutions, require a change in human ideas, values, social structures and policy decisions associated with water. My discussion of the value of local traditions and changing socio-institutional dynamics shows that traditional water paradigms contain the integrated knowledge-practice-belief complex. My research indicates this integration and unity in the Iranian case. I also have attempted to examine the origins of the modern illusion of water abundance and the subsequent water waste. This illusion had been carefully prevented by a set of participatory socio-technical practices in the traditional paradigms.

A few points are necessary to mention in summarising the conclusions about characteristics of each water paradigm at all the levels. Local communities in the process of trial and error during the centuries learned that they need a strong sharing ethic among different water stakeholders who, in the absence of this moral system, might be in conflict. Traditional water paradigms, by sacred meaning, could maintain a balance between human demand and water resource capacities in the past. As a result of local water paradigms, water management is treated as a socio-cultural phenomenon and as a part of the larger social context. Consequently, compared to the Western-orientated counterparts, in traditional water systems water users are more engaged with water realities. In the traditional paradigm, water is perceived as an expensive good that is difficult to access. Therefore, it has to be saved and regarded as something sacred and spiritually respected. On the other hand, as the environmental and social consequences of the huge water projects started to be criticised, it became clear that social and technical practices of modern water management concealed the realities of water scarcity. Absence of a sacred conception of nature puts producers at

a high risk of destroying their material sources. By oversupply of water, modern water paradigms conceal water realities and create exploitative viewpoints towards water resources. Dominance of the technical discourses has led to disconnectedness of water management with its socio-cultural contexts. This disconnection creates a division between people and their natural resources. Furthermore, the materialistic worldview of Western natural resource management has focused on physical water and ignores the many water contexts including spiritual meanings and associated social responsibilities. Under assumptions of the modern paradigm, these traditional water meanings have been treated as disposable. As a result of the decades of the Western-style development, these animistic beliefs have been abandoned without attention to their associated conservational functions. Finally, modern socio-physical infrastructure has made water a cheap and permanently accessible economic object. In this way, the wasting of water would be the final outcome. The current crisis indicates that advanced water technologies have not solved the problem. On the contrary, modern water infrastructure created many problems by artificial oversupply of water and making the real water sources invisible. "The march of development cannot wait to even find out what is that it is about to destroy" (Posey, 2002: 59); in the same way, the final consequence of the water paradigm shift in Third World rural communities has been the loss of millennia of knowledge about life in adaptation to various ecosystems, reflecting the tragic human cost of economic development.

To give an outline of chapters, it can be said that chapter one introduced the worldwide water crisis. More specifically, the situation of water overexploitation in Iran was addressed and my research questions and aims through which I intend to study the traditional and Western-oriented water paradigms were presented. In chapter two, I discussed the most relevant approaches within the ecological anthropology disciple as well as some concepts that originate from the wider qualitative research. The literature review chapter examined some similar local systems of water management across the globe. In chapter four, following the contextual method of the qualitative research, I investigated the general social contexts within which the Qanat technology functions. Then, I described the various levels of the Qanat system including technical, social and ritual aspects. Similar to chapter four, chapter five started with the general socio-cultural contexts of a social revolution which has led to

the collapse of the traditional water management in Iran. Afterwards, I explained the alternatives to the technical and social structures of the Qanat system. Chapter six discussed the results of my study of the traditional and modern water paradigms in Iran. These results about water management in Iran were presented by the use of the four-level framework and also according to a distinction of the traditional and modern water management in Iran. In chapter seven, general conclusions concerning a global contest between local and central government-based models of water management were offered. Finally, chapter eight will propose some recommendations about the applicability of ethnohydrologies to modern contexts and also the possible ways of reviving the socio-managerial aspects of the Qanat-Boneh system.

In the following chapter, I offer some practical recommendations which mostly concern the organisational dimensions of a co-management model.

Chapter Eight: Recommendations

Chapter introduction

This chapter extracts more practical lessons that can be learned from my key arguments in this study. The first section regards the general recommendations about water systems across the world and considerations about how traditional systems can contribute to water policy reforms. For this purpose, I provide a brief review of the ways in which local user groups can be incorporated into water management. I discuss the issue of regulating relations of different water stakeholders which takes place through a co-management model. As I argue, applicability of the traditional water paradigm is not restricted to the techno-physical dimension of water management. This means a co-management model takes a holistic approach within which socio-cultural aspects are as important as technological issues. In the second part, Qanat-related recommendations are presented. Suggestions about Qanat cover some arguments and examples of social revival of the Qanat-Boneh system such as the imported Bonehs in western Iran.

Some considerations about applying traditional water management to the modern contexts

Resource problems in society today exemplify the "Tragedy of the Commons". According to this concept, morality of commons includes self-interested individual decisions. This kind of morality under high population conditions has generated environmental tragedies (Hardin, 1968). Therefore, solving the water crisis requires a change in human perceptions, morals and social structures associated with water. Although the physical elements of TEK systems are generally more eco-efficient, the TEK literature does not recommend contemporary water policy revive just the techno-physical elements of traditional systems. This is because a technical solution requires changing natural sciences techniques, not a shift in human values or ideas (Ibid). However, TEK systems have "moral solutions" (Ibid) for our resource problems, due to the fact that they regulate sustainable human-environment relationships by a set of

eco-friendly practices and values. Thus, in addition to technological progress, we should learn how pre-modern sociocultural structures shape more eco-friendly relationships with nature. This aim is achievable by incorporating some parts of traditional values and principles into water policy, the values which "make people care" (Strang, 1997: 7) about water realities. Since the technological details are beyond the scope of my research, my recommendations focus on the socio-organisational level of the water paradigm.

During recent decades, integration of indigenous knowledge into development projects (Setyawati and others, 2004) and the feasibility of applying TEK to contemporary resource problems have been gradually recognised in various parts of the world (Berkes, in Inglis1993: 2). This recognition has led to a growing acceptance among international aid agencies about the relevance of TEK to the success of development projects (Healy in Williams, 1993: 22). The "wave of water reform across different countries" (Whiteley, 2008: 191) with attention to the local water systems is a result of the same process. Meanwhile, there are many details in the models of incorporating TK into development process. The main consideration regarding operationaliation of TEK studies is how to translate the results of the projects, such as my research, into the language of policy. Again, despite "the problems that complicate the use of TEK" (Posey, 2002: 15), development projects with an indigenous knowledge component are growing and becoming widespread throughout the world.

Characteristics of a co-management model

Co-management models include a complementary system of traditional and modern methods. They have been labelled with different names such as community- based natural resources management, participatory management and management transfer (Meinzen-Dick and others, 2002).These models can be characterised by the integration of traditional (indigenous and small scale) and modern (scientific and large scale) technological infrastructure, by participatory water resources management in the form of multi-stakeholder platforms or water user associations, and also by its recognition of the diversity of cultural values of water.

Complementarity to the Western-orientated model is the first characteristic of co-management models. This feature means that despite all the advantages of TEK systems, going back to the past is regarded as the simplification of the water management problems. As was pointed out earlier, TEK is complementary to Western science, not a replacement for it (Berkes, 1993). Hence, the recommendations inspired by ethnoecological research mostly suggest an integrated technical and social co-management. The same point was emphasised at the Fourth World Water Forum of 2006 in Mexico (The Fourth World Water Forum, 2006). At the Forum, there was general agreement that nations should consider both small-scale decentralized solutions and large-scale approaches involving dams and reservoirs to meet their needs at the lowest possible social and environmental costs. The forum recommended trying to reach "a proper mix of science, technology and local knowledge' (p: 54). As my analysis in chapter two and three insisted, one of the reasons that traditional water systems can not be the total replacements for modern alternatives is that there are some disadvantages about TEK systems. The main disadvantage is hierarchal inequality which should be avoided by contemporary societies. In other words, ethnohydrological systems should be applied to a modern context without discrimination among water stakeholders. According to this characteristic, co-management systems need to be patterns of collective action under present-day egalitarian circumstances with participatory not hierarchical arrangements.

Co-management systems emerge when a resource has a number of parties with different interests and rights (Binder and Handbidge, 1993). Therefore, the lesson that we can learn from traditional organisational principles is how to regulate relations of these different stakeholders. Given this fact, water reforms have mainly focused on institutional reforms; subsequently, water institutional reform has become a major theme of the international literature on water crisis (Sehring, 2009: 20). In the same way, the practical considerations that I discuss mostly regard the socio-institutional level of water management system. The most important characteristic of a co-management model at the socio-organisational level of a water system is the participatory or multi-stakeholder approach towards water management. Water stakeholders can be farmers, policymakers, water experts, etc. The core idea is that multiple stakeholders, who have different interests and needs concerning water,

should organize and arrange water use and conservation issues through different forms of cooperation, including building capacity for collective learning and decision making. The model should also include meaningful communication between local people and development personnel. Participation, consultation and inclusive political institutions to enable the mediation of the conflicting interests of water users and the agencies which manage water" (Allan, 2006: 7) are all parts of this model.

There are some other issues regarding multi-stakeholder water management. The assumptions upon which water policy is designed should be reconsidered. After the Second World War, it was a common supposition that development must focus on the state-building and large-scale state projects. Then in the 1980s the focus was placed on market and private-sector alternatives to state-driven development (Ostrom and Shivakoti, 2002). According to Ostrom, donor agencies need to direct their efforts toward enhancing governing capacities of smaller communities rather than to replace the current infrastructure with modern, technically sophisticated technologies. (Ostrom and Shivakoti, 2002). In this regard, Coward (1997) also emphasises that the indigenous principles of organisation are more applicable in small-scale irrigation systems. But as Coward concludes, it is still possible to create some of the contextual properties of indigenous water management in the design of even large-scale irrigation systems that are funded by national and international agencies. Furthermore, he extracts some organisational principles from traditional water management systems such as accountable leadership and mini-unit organisation. The next point is that water management personnel should be appointed from local water users rather than the labour employed by government. Following this, many water-user associations are emerging in some Middle Eastern countries. In brief, according to this characteristic, water co-management requires a new holistic approach with much stakeholder consultation and public participation to enable successful conflict resolution and consensus building among water users and water management agents.

Another major dimension of participatory water management is the responsibility transfer process. The co-management trend and consequently the multi-stakeholder water model is, to some degree, a responsibility transfer process. The trend towards co-management includes devolution of responsibility over natural resources from central government to local user groups. This responsibility transfer does not mean

devolution of full responsibility and control to local communities but rather a reasonable increase in users' involvement in management (Raju and others, 2002). Since local users' livelihoods depend on the resources, they have advantages over government agents (Raju and others, 2002); therefore, they can devise institutions to manage the resources more sustainably. Finally, promotion of collective responsibility, water users' engagement in various water practices and informing water consumers of water limitations are among the goals that are achievable through devolution of responsibility.

Recommendations based on the Qanat system

To sum up the Qanat-related recommendations, the best way to put the current chaos in order and regulate water consumption is to benefit from the lessons of traditional water management in rural Iran. In this regard, the practical recommendations should focus on how to resolve the inequities of the Qanat/Boneh system, while maintaining its strengths. The government should encourage the rehabilitation of the Qanat underground system and its integration with the modern water supply systems. For this purpose, some modern mining technologies can be applied to enhance the water efficiency of the Qanat system (Kordovani, 1984). Furthermore, individual farmers who are entitled to land and water ownership need a unifying socio-organisational model regarding water more than the techno-physical infrastructure. Accordingly, more is needed than the purely technical restoration of the Qanat system. Apart from physical revival of the Qanat system - which is not my major research goal - reviving certain social aspects of the Qanat system should be the main aim of anthropological research. As one scholar stated: "the social dimensions of the traditional water system in Iran are restorable before they are forgotten" (Safinejad, 1989: 15). These traditional agricultural structures are revivable in the form of Boneh-like organisations (Ibid). If the system of Boneh was modified, the interaction between the members of the agricultural units would remain, and in the hope of a promotion the farmers would try to overtake each other in optimizing water (Farshad and Zink, 1998). Ultimately, a kind of montage of traditional and modern elements should be created in a way that does not contradict the new conditions of rural society of Iran (Ibid).

An extremely important example of the revival of the Boneh system is the case of imported Bonehs in western Iran. Some local landlords brought a number of farmers from eastern parts of Iran to the western province of Khuzestan. These collective farming units, called "Bonkooh", were introduced to the regions where, because of water abundance, farmers didn't need much collective agriculture. Nevertheless, the landowners found the Boneh system efficient and used it (Safinejad, 1989). In this western province of Khozestan, several successful Bonehs were established by modelling Bonehs of the eastern part of Iran in 1947. In these units, landlords provided farmers with land and water, then farmers collected other factors of production and finally cultivated through these units. The product was divided into a certain proportion between the owner and farmer (Safinejad, 1989: 546). The experience of this importation of the Boneh system indicates that product and labour division can be more egalitarian compared with the old Bonehs before land reform (Safinejad, 1989). Because the most important foundation of the Boneh system is based on the commonality of water and land among farmers, the percentage of product division does not have to be unequal.

To apply Iranian ethnohydrology to a contemporary context, we face the problem of reconciliation between managerial advantages of the Qanat/Boneh system and its inequalities. In other words, this is a matter of how "to incorporate indigenous knowledge into the development projects" (Bicker, 2004: 60), a question which needs further research. More details about how to include the Qanat-Boneh system into development projects can be the topic of my PhD research in the future. At this stage, it can be claimed that according to the main experts of the field, managerial and institutional aspects of traditional water management of Iran are detachable from the country's feudalistic and discriminatory dimensions. This fact can be the foundation of implementing the Qant-Boneh system to a modern context.

Chapter Conclusions

This chapter was a review of the possible ways of using traditional water knowledge for more sustainable water management. In other words, the chapter discussed how to apply some social and managerial dimensions of the Qanat-Boneh system while resolving its inequities. I argued that local water systems can have implications for both the theory and policy. I made a few generalisations based on the studies of hydraulic traditions which can be helpful for the temporary water management. The starting point was the notion that ethnoecological holism does not recommend contemporary water policy to revive only the techno-physical elements of traditional systems. Hence, apart from techno-physical reforms, we need a community-based co-management model that works through consultation and negotiation with local people. This co-management model complements the Western water paradigm. Moreover, participatory or multi-stakeholder management in the form of water user associations and responsibility transfer are among the main institutional characteristics of this co-management model. Also, the ultimate aim of taking a responsibility transfer approach is engaging locals with water realities. In the end, all the above factors together can incorporate local socio-cultural values into the water paradigm. This finally leads to resocialisation and localisation of modern water management in contemporary societies.

Glossary

Arbab: landlord

Abyar: water master or irrigator, the highest position in a Boneh

Barzgar: farmer, the lowest position of the hierarchy of Boneh

Khoshneshin landless agricultural labourer

Mobasher: landlord's representative

Mosha: the collective agricultural units in Iran after the revolution 1979

Nasaqdar: sharecroppers

Sarboneh: Boneh head, a person selected by the landlord or his representative

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