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Chapter 9 Comparison and conclusion

Introduction

This chapter concerns the question, which various socio-cultural and biophysical elements in qanats as human ecosystems can be identified in relation to its use and maintenance. I aim to provide an answer by providing a comparison between our two presented case studies of Shallalah Saghirah and Qarah. I will present a human ecosystem model to contextualise collective action and identify various elements of qanat systems to guide us in our comparison. The importance of the assessment lies in the analysis of various contextual elements that influence collective action in a Middle Eastern environment in order to place qanats and their maintenance in a development intervention context.

First, various biophysical and sociocultural elements to include in qanats as complex human ecosystems and how to visualise them will be explored. I will look at qanats as human ecosystems whereby the users are integral part of the biophysical system. The qanat system is considered as a socio-geographic unit that is nested in larger systems on regional, national and international scales (*cf.* Uphoff, 1998; Pavao-zuckerman, 2000; Stepp e*t al.*, 2003).

Secondly, I look at transformations taking place in the multiple physical, biological, social and cultural environments of qanats and their users in respective case studies. Transformations taking place at different scales in the wider supra human ecosystem, shape the individual and local experiences of users and consequently determine the orientations-to-action per user or per group of users (*cf.* Uphoff, 1998; Molle, 2004). Hence the longer-term sustainability of qanats relies on how the users' orientations-to-actions are shaped. Molle (2004) finds similar developments in his study of a qanat village in Iran where interventions and event at different scales, such as the introduction of a dam or pump wells, influence other parts in the wider basin.

This brings us to a third consideration; the energy input into the human ecosystem in the form of collective action to maintain qanats. Wilkinson states that the quality of a qanat system should not be measured in terms of its length and depth but of its ability to flow for a long term (Wilkinson, 1977). Sustainable collective action of its users community is vital to achieve a longterm flow of a qanat. We will look at the local histories, context, perception and the relation between collective action, heterogeneity, exit options, power and leadership.

Organisation of this chapter

The first part of this chapter attempts to analyse various elements of a qanat as human ecosystem. The second part concerns an in-depth comparison between the two sites and how this can give clues on the influence of transformations on qanat use. It will also look at transformations that are continuously taking place in the wider world in relation to the two case study sites of Shallalah Saghirah and Qarah. The third part discusses the "energy" input in the form of collective action necessary to keep qanats "alive". It looks at the importance of local history, perception, power and heterogeneity. In conclusion, the final section presents the main conclusions of this study in relation to my research questions and provides policy recommendations.

9.1 Analysing qanats as human ecosystems

In this section, the various elements of qanats as human ecosystems will be explored. We will look at the qanat as a complex human ecosystem at community level. At higher levels, a qanat system is part of a wider complex with other human ecosystems. In this approach, sociocultural and biophysical transformative processes are incessantly taking place in a supra human ecosystem. This concerns for example communities that conduct groundwater extraction both by means of pumps and qanats. The above is important for assessing the sustainability of qanats; ecosystems are sustainable when the social and the physical/ecological elements are co-adapted and in balance (Marten, 2003).

To survive, the qanat system needs energy intake from this wider environment. It relates to the second law of thermodynamics, which points out that energy always flows from one state of high energy to another of lower energy. This energy intake is in the form of both "social energy" (collective action, commitment, water use) and "physical energy" (sunlight, rainfall, water supply, construction). If these energy flows do not take place, the qanat system reaches a "terminal state of equilibrium", in other words "dies" and dries up.

Outcomes of transformative social and biophysical processes (population growth, economical changes, industrialisation, political change, war, drought, earthquakes, climate change etc.) in the supra human ecosystem are irreversible. The human ecosystem changes and it will be impossible to return the qanat system to its state prior to the transformation. It means that you cannot define qanat restoration in the form of a return to a supposedly "balanced" state prior to the change. We can only look at those relics of the past that kept qanats "alive" for such a long time. This calls for a pragmatic, practical and adaptive approach that

takes into account new and old water abstraction technologies, changing irrigation methods and continuous socio-political transformations in the supra human ecosystem.

9.1.1 Elements of the qanat as human ecosystem at community level

The qanat users as consumers in a human ecosystem are surrounded by multiple social, cultural, biological and physical environments containing elements that interact with each other. Qanats as human ecosystems are extremely complex ecosystems; the following overview of elements is a conceptual model and certainly not exhaustive but it attempts to visualise the main elements we observed in relation to qanat systems in Syria. We start by looking at a qanat community as a consumer unit embedded in cultural, social, biological and physical environments symbolised by concentric spheres (Figure 56). We have used symbols adapted from Heemskerk *et al.* (2003) of their exploration in using conceptual models as interdisciplinary communication tools (Figure 57).

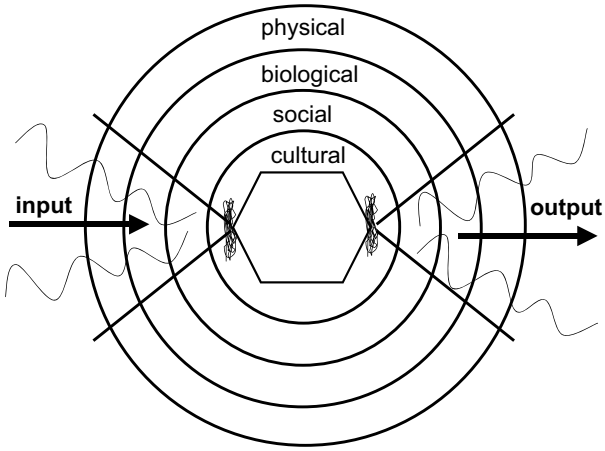

Figure 56 – Representation of qanat community as a consumer unit (adapted from Stepp et al., 2003)

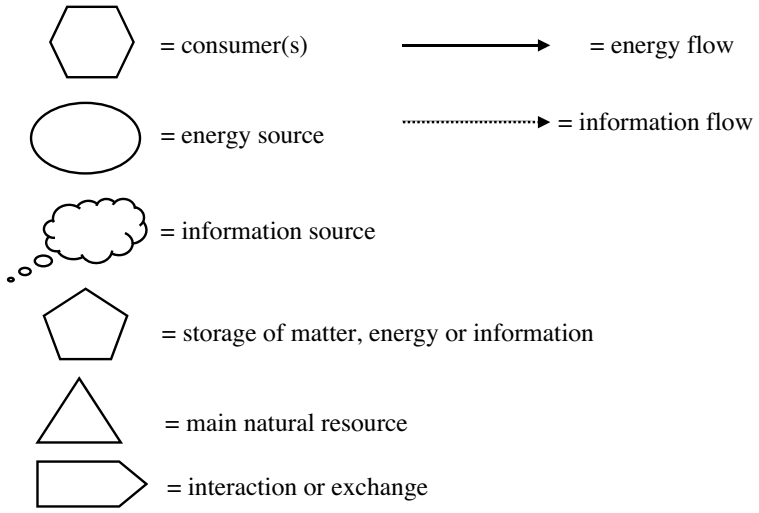

Figure 57 – Symbols used in representation of human ecosystem

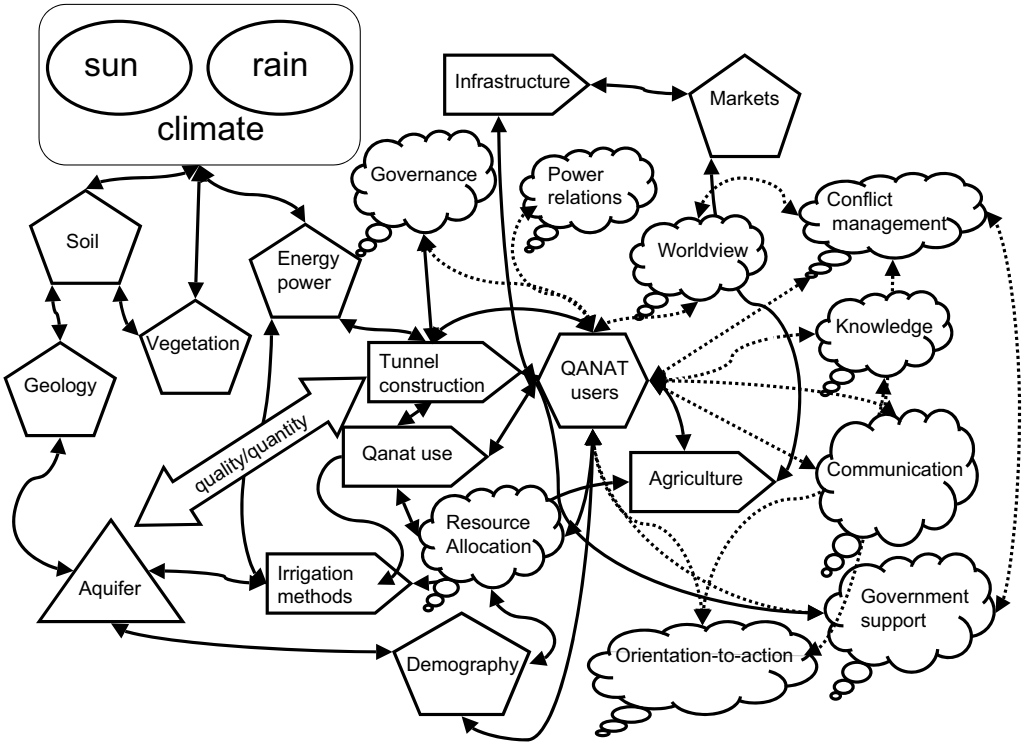

Figure 58 – Partial representation of a qanat as human ecosystem

Figure 58 gives a partial representation of a qanat as human ecosystem where biophysical and socio-cultural elements are found in a configuration that serves as an ecological energy input and output system.

Biophysical elements

Identified as main biophysical elements are climate, rainfall and solar energy, geology, soil, energy power, water quality and quantity, vegetation and agriculture, tunnel construction, irrigation technology, physical infrastructure. Geology, rainfall, water quantity and groundwater levels are among the most important physical elements for the sustainability of the qanat as a human ecosystem. There are a number of biophysical reasons why qanats may fail locally: climate change and drought, earthquakes, a drop in level of the water-table due to overexploitation or the construction of the qanat itself (Lightfoot, 1996; Beaumont, 1989; Wilkinson, 1977). In those sites where falling groundwater levels have not yet affected qanats, it is more likely that renovation succeeds. Traditionally when groundwater levels were receding, the qanat was prolonged or a reservoir ("*birkeh*") built to collect the water before dividing it to the farmers. A consequent implementation of the traditional law of "*harim*" around a qanat is aimed at ensuring a stable groundwater level. However this does not work when the qanat draws it water from deeper aquifers recharged outside the *harim* borders. The entry of fossil fuels and electricity for power directly affected the use of qanats as means of irrigation. It paved the way for the use of water pumps that were in direct competition with qanats for the aquifer exploitation.

The qanat construction is another important physical element of the qanat as human ecosystem. Within the traditional realm, many of the ancient qanat workers died due to the nature of the job, accidents and collapsing of tunnels. The infiltration based qanats that were observed were badly damaged by floods and poor maintenance. Stone lining consisting of basalt or hardrock slates strengthens weak parts of the tunnel. Spring based qanats have the strongest construction in Syria. They are dug in hardrock and most of them are consistent over the entire length. In the water transport areas however, supportive beams and walls are observed to prevent collapsing of the tunnel. If there is any doubt about the consistency of the underground tunnel construction, care should be taken and renovation always reconsidered out of safety reasons.

Today, materials such as concrete and cement are used for construction. Supportive iron beams and scaffolding to prevent collapsing when cleaning the unsafe parts are a good solution. A safe way to renovate infiltration-based qanats is the complete removal of top soil which leaves an open trench. This trench can be covered with a U-shape

tunnel either made of concrete or other lining material. The U-shaped tunnel is place upside down and the bottom of the tunnel is open in the water production section to allow infiltration and lined in the water transport section to prevent seepage. This technique is used in Oman where special developed reinforced concrete is used as construction material. Obviously this is a costly operation.

Vegetation, irrigation methods and technologies are important biophysical elements for the use of the qanat water. Irrigation technology determines the water use efficiency and can serve as a control measure of the water demand. If a qanat is to be used for irrigation, the amount of discharge should be enough for at least a certain degree of self-sufficiency. If the discharge provides a good surplus and the local physical infrastructure and markets are favourable, irrigated agriculture will enhance qanat use. However, as we have observed profitable agricultural production does not have to be the main drive for keeping qanats alive. Drinking water supply is as important and there are numerous examples of qanats that are maintained without a thriving irrigated agriculture economy.

Socio-cultural elements

Identified as main social elements of the qanat as human ecosystem are orientation-to-action, power relations and agency, conflict management, communication, governance, government support, knowledge, worldview (i.e. information and belief systems), markets, demography, water use and resource allocation.

Governance and resource allocation are important socio-cultural elements. The willingness of users to maintain the qanat is guaranteed by a system of financial contribution to a representative governing body of qanat users. However we see that growing markets force qanat users to look for other means of investment. The economic profit of the qanat is an important dimension for the development of the level of local commitment in maintaining the qanat. It also relates to a level of opportunism in a community; new interventions in the human ecosystem could be an opportunity to redefine water rights in order to make profit from the qanat water. Similarly Vincent (1990) found in Yemen that some water projects turned from disputes into conflict due to this opportunistic spirit. She warns for the nature of potential opportunism that needs to be considered in the early stages of a project that concern changing economic circumstances.

We have found that power relations concerning qanats are based on a strong hierarchy and unequal relations between users and shareholders. The biggest shareholders are represented in the qanat committees and often have the most important vote in decision making on

resource allocation and maintenance activities. The local decision making processes concerning qanats is based on consensus and unanimous agreement rather than a majority vote. Abraham & Platteau (2004) state that in close-knit societies majority voting is not acceptable because it would "*officialize the existence of disagreements and the minority would feel justified to behave as it likes*". The majority voting principle is then a threat to the continued personal and amicable relations that determine the reproduction of the group (Abraham & Platteau, 2004).

One important social element is the worldview of users that is distinctly influenced by previous experiences and local histories. We saw in the pilot study that events in social history strongly determined the actors' orientation-to-action. The changing worldviews affect for example the relationship between the older and younger generation and are a cause of conflict. Where the older generation generally has a strong sense of tribal affiliations and prefers a peaceful rural life, an emotional need that has been termed "biophilia" (Marten, 2003), the younger generation prefers a modern urban environment where the secular society and individual development is at the forefront.

If we look at conflict management, we conclude that a strong local leadership is a condition for management of qanats as a common water resource. Serious disagreements are likely in communities with lack of leadership, internal divisions and historic feuds over water resources (Vincent, 1990). Vincent describes that dealing with disputes is an important source of validation and in much disputing is highly ritualised in many societies and even have a strengthening role (*ibid.*). She does warn that conflict on the other hand, is more dangerous and can cost development interventions considerable damage (*ibid.*). In Shallalah Saghirah, we saw that internal disputes often have very little to do with actual water management and are found in the personal spheres of family relations, marriage, gossip and family honour. If the disputes are not managed properly the resulting situation can turn into conflict and seriously reflect on collective action and social cohesion necessary for qanat maintenance. The resource scarcity can then be related to conflict in three ways: as proximate causes, as means of conflict and a rationalisation of the conflict (Naff, 1994). In Shallalah Saghirah we see that the access to the scarce water supply is used as means of sabotage between conflicting parties.

Power symmetry and asymmetry are vital keys to conflict management at community level. If power is asymmetrical e.g. one actor holds such a predominant or hegemonic position to be able to determine whether and in what circumstances cooperation will occur, then overriding interests will induce cooperation rather than conflict (Naff, 1994). In the traditional Arab rural areas, a strong village, religious, tribal

or family leader is a condition for good conflict management and social cohesion. It is observed that where maintenance and management of qanats is successful, like in Qarah and Dmayr, power relations are traditionally asymmetrical. However the rate of migration and changing worldviews of younger people influence the traditional social cohesion negatively. In these cases, individualism, power symmetry and decentralization have taken over and the traditional collectivism is weakened. Hence the abandonment of qanats is enhanced.

Looking at communication as a social element there are differences in the approaches used to convey and receive information. Whilst in traditional Arab culture, the public scrutiny and honour guide indirect personal communication, a participatory and decentralised approach is focused on direct communication without the overriding influence of honour. There is a certain intimacy in the traditional approach, important are the primacy of personal involvement and reputation of the communication partners. In a participatory approach, openness and transparency in communication are highly valued and other media than verbal language will also be used to convey ideas such as video, internet, television. It is the more Aristotelian approach whereby emphasis on communicator, influencing, control and intellect and rational action are important (*cf* Feek & Morris, 2003). The participatory "democratic" directness can clash with the traditionally Arab form of communication that is bound to social rules and regulation, mainly to avoid loosing public face and not to embarrass your communication partner. We saw good examples of that in Shallalah Saghirah. However, forms of communication such as video, enhanced collective action in Qarah.

In terms of governance, a clear definition of ownership is necessary to avoid conflict after qanat renovation. The user community bears the ownership and consequently the responsibility for maintenance. It is necessary to have a defined system of rights, control and regulations on water, to be used when water increases or flows after maintenance. Newly established institutions such as introduced water users associations could not easily manage a qanat. We see that where the customary systems of governance have a long uninterrupted history and are still in tact like in Qarah, the qanats are maintained. At those sites where the local history of governance was not that old, or interrupted, the local institutions were relatively weak. Those qanat systems were most vulnerable for transformations in the wider world that influenced qanat maintenance negatively such as the introduction of diesel power operated pumps.

9.1.2 The human ecosystem at regional level; are pumps and qanats compatible?

Looking at the qanat human ecosystem at a wider regional level, for example a watershed, we see there is a co-existence between the use of diesel power operated pumps introduced after the emergence of mechanised technology and the use of gravity led subterranean tunnels. Figure 61 shows the communities of borehole users and qanat users as separate consumer units in a wider ecosystem competing for the same natural resource (water).

In a mechanised situation we find the use of pumps, operated by fuel with costs depending on world price fluctuations. We see the use of surface water irrigation using furrows but can also observe advanced irrigation techniques like drip irrigation that are further developed by continuous agricultural scientific research. Furthermore in this situation, the farmer is focused on private ownership of the borehole. We find a dominance of individualism in a decentralised system;

Everybody owns his own water supply and the production is focused on the market demand. Governmental laws on well drilling aim to prevent the drying up of aquifers. In an ideal world this could be a sustainable system, however the reality is that population growth increases water demand exponentially. Poor legal control causes an evasion of the laws and over exploitation of groundwater. Wakil (1993) confirms that increasing water demands and therefore the fall in groundwater levels in

Figure 60 - Borehole users

Figure 59 - Qanat users

Syria are determined by two factors only: population and irrigation.

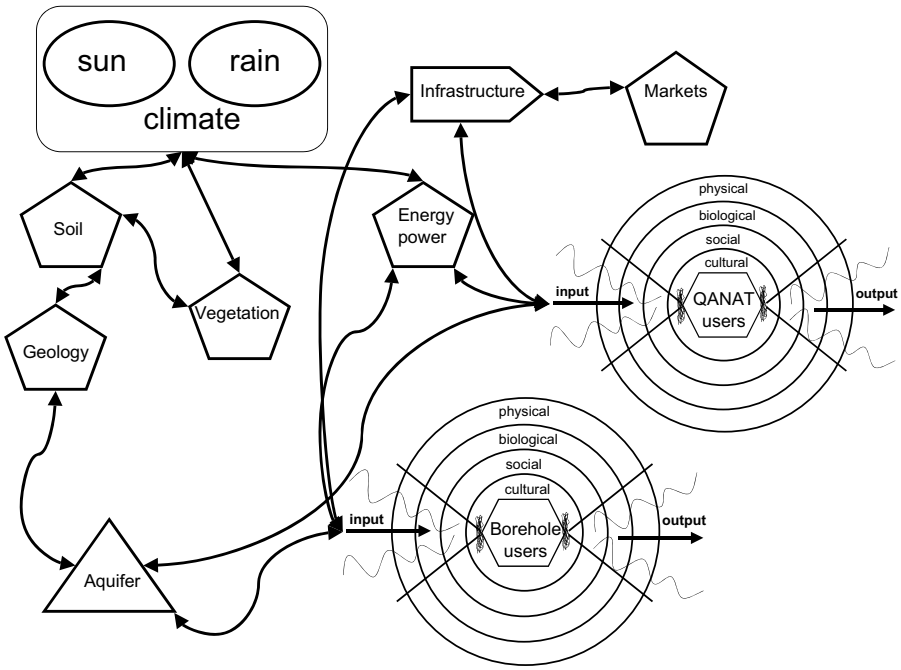

Figure 61 - Partial representation of a qanat human ecosystem at regional level

In a non-mechanised situation, we find qanat tunnels that draw groundwater to the surface using only gravity. Because it relies on a natural balance between outflow and inflow from the source aquifer, the tunnel can never take more water than is recharged by rainfall. Airshafts to provide air to the excavators charged with their upkeep intersect the tunnel. The type of irrigation is flood irrigation. The maintenance, water use and irrigation are based on a strict set of local rules concerning inherited or traded rights and duties towards the qanat system. Drilling of wells in the vicinity of the qanat is forbidden, based on "*harim*" which finds its origin in Islamic law. Traditional knowledge provides informal education on qanats that is passed from generation to generation. It concerns knowledge on the regulations, maintenance and technological aspects of the tunnel construction. In most cases, the qanat is communally owned and through a highly centralized organisation of guards and irrigation shareholders there is a collective responsibility for the qanats' sustainability both socially and technically. When maintained well, the qanat provides a long-term profit aimed at self-sufficiency of the direct users group. Ideally, this human ecosystem is environmentally sustainable.

With the arrival of mechanised technology in Syria, qanat systems are gradually imploding and consequently abandoned at various sites. Industrialisation impacted irreversibly on the qanats as human ecosystem. In other words the human ecosystem was "disturbed" by the emergence of industrialisation. The disturbance is similar to the "disturbed harmonies" that George Perkins Marsh wrote about in 1864, as quoted by Ton Dietz (1996). However, Perkin Marsh separates man and nature whilst in my approach man and social systems are part of nature. In the case of qanats as human ecosystems, the disturbance is not brought about by the supposed interference of human entry into a biophysical system. The arrival of industrialisation is seen as a transformative process that caused the disturbance. With the Industrial Revolution, technology, machines and fossil fuels seemed to free people from many environmental limitations (Marten, 2003). Industrialisation, mechanization, the green revolution and global socio-economical changes cause farmers that use qanats, to look for faster and quicker profit. They drill diesel operated boreholes to meet the growing demand.

Another major transformative process in Syria that impacted on groundwater use was the rise of the Ba'ath party and the land reform that started in 1958. The combination with industrialisation processes greatly impacted the land and water resources use. The young generation was pulled towards the cities to have jobs, as they want to invest in cars and other modern facilities for which they need a regular and higher income. This migration of the young generation is a major factor causing abandonment of qanats. In the worst-case scenario, the traditional knowledge of the qanats is lost with the abandonment and eventually all qanats will be left as relics of the past. Unfortunately it seems a likely scenario in Syria. The problem today is that modern agricultural ecosystems have lost their co-adaptation with the surrounding natural ecosystems (Marten, 2003). The challenge is to work towards a more positive scenario, a new adaptive development in which both qanats and pumps can live side by side without depleting the groundwater resources, thus recovering from the "disturbed harmony" into a resilient human ecosystem. In the following sections, we explore transformative processes that took place at our respective case study sites.

9.2 Comparison of socio-cultural and biophysical elements at each case study site

This section gives an explanation of the differences and similarities of the social and biophysical elements in the human ecosystem at each renovation site. It will place the elements in relation to transformations that took place in the wider ecosystem. For an overview, a

matrix is developed to compare the various sociocultural and biophysical elements of the case study sites (Table 25).

Elements	Shallalah Saghirah	Qara
Biophysical elements		
Geology, soil and morphology	*Dominant chalky limestone hardrock plateau. Karsts. Local names for specific soil and rock types.*	*Dominantly chalky limestone hardrock plateau. Karsts. Local name system of various soil and rock types.*
Climate and rainfall	*Erratic rainfall. Between 200-mm and 250-mm. 2002/03 above average. Arid climate.*	*Erratic rainfall. Between 200-mm and 250-mm. 2003/03 below average. Arid climate.*
Water quality	*Not up to WHO standards.*	*Not up to WHO standards.*
Water quantity	*0.29 l/s (2000)* *0.35 l/s (2001)*	*3 l/s (2001)* *0 l/s (2002)* *3,4 l/s (2004)*
Vegetation and agriculture	*Desert shrubs, occasional rainfed barley, irrigated fig trees and vegetable patches, sheep fattening.*	*Desert shrubs, irrigated horticulture, barley, grapes, vegetable gardens.*
Tunnel construction	*Limestone rock type qanat, spring fed. Dug into rock. Byzantine origin.*	*Limestone rock type qanat, spring and filtration fed. Part built. Byzantine origin.*
Irrigation methods	*Flood irrigation.*	*Combination flood and drip irrigation.*
Infrastructure	*Relatively isolated. Poor public transport connection.*	*Well connected. Good public transport.*
Energy power	*Gravity, no electricity. Individual generators.*	*Gravity, electricity present. Diesel fuel pumps.*
Orientation to action	*Self-regarding cooperation; opportunism prevails.*	*Other-regarding cooperation; mixture of opportunism and collectivism.*

Elements	Shallalah Saghirah	Qara
Power-relations	*Unequal power relations and a lack of recognised leadership. Proximity to resource and social network main powerbases.*	*Unequal power relations but strong recognised leadership. Irrigation rights and social network main powerbases.*
Conflict management	*A repetition of unresolved feuds, jealousy and internal divisions*	*Long history of traditional social organisation, with recognised mediators for conflict.*
Communication	*Interpersonal communication, public scrutiny, collectivism*	*Both interpersonal and technology, individualism, emotional distance.*
Knowledge	*Low level of local knowledge about qanat and its renovation. Collective memory and nostalgia.*	*Medium to high level of local knowledge about qanats and their maintenance. Qanat symbolism for prosperity.*
Worldview	*Religious conviction determines actions in daily life; customary family law and tradition are most important; fatalism dominates. General preference of peaceful rural life.*	*Different religious convictions coexist; a certain fatalism at rural level; exposure to wider world through main actors and proximity of state capital.*
Resource allocation	*Irrigation rights based on inheritance law, use right only tradable among family members. Renting allowed. Land and water rights connected.*	*Irrigation right based on inheritance laws and/or trade between individuals. Land and water rights connected.*
Governance and leadership	*Hundred year old governance based on customary law. Village elders govern the use and maintenance.*	*Thousand year old developed system of governance. For many users since time immemorial. Qanat committee governs use. "Natur" plays crucial role.*

Elements	Shallalah Saghirah	Qara
Government support	*Isolated site, government services do not reach to provide regular basic services.*	*Relatively close to the capital, good access to government services, interest from state directorates for its qanats.*
Economy/market	*Off-farm migration to provide alternative income, exposure to modernity causing discrepancies within the community.*	*Overall urban migration of young generation; juxtaposition of young urban migrants and older pensioned farmers.*
Demography	*High birth rate; causing pressure on land ownership and water resources because medical services better than in the past.*	*Explosive urbanisation of Qara, high birth rate increasing pressure of water demand.*
Qanat use	*Qanat used for free drinking water and controlled irrigation, not for external agricultural market. No piped water supply. Over-exploitation by pumps in nearby aquifer but qanat not affected.*	*Qanat primarily used for irrigation water, agriculture for household use and external markets, governmental piped water supply for drinking except for major water right holder (monastery). Over-exploitation by pumps in main aquifer.*

Table 25 – Comparison of elements of case-studies as a human ecosystem

9.2.1 Bio-physical elements

Geology, morphology and rainfall

Both sites are placed in a dominantly karstic and chalky limestone plateau. Both sites have local names for geological formations and in Qarah the users make regular use of a traditional *zahori* for geological explanation. The areas both experience erratic rainfall with an average between 200-250 mm with Qarah slightly drier and at higher elevation than Shallalah Saghirah. Among the natural causes, which might explain why qanats and their irrigated land have been abandoned are changes in the regional climate (*cf*. Wilkinson, 1977). Rainfall and droughts are interpreted as divine acts that are irreversible and both communities have reported a general downward trend in amount of rainfall.

Water quality and quantity

Both sites experience water quality problems ranging from the occurrence of E-coli to the presence of calcareous deposits in the water. The main health risk is found in Shallalah Saghirah where the qanat water is used for drinking. The risk is highest for newborn and small children. In Shallalah Saghirah the supply is sufficient for the communities basic needs but not for profitable irrigated agriculture. In Qarah, the qanats do not provide sufficient supply to the entire town's population therefore the government provided piped water supply. Irrigation water is supplied to those who own water rights. Water scarcity is pressing and causes farmers to react with changing crops and irrigation technology.

Vegetation and agriculture

Both sites have natural dryland vegetation that suffers from processes of degradation and overgrazing. There is agriculture consisting of rainfed and irrigated barley, fig, olive and plum trees, vegetable gardens with tomatoes, eggplants and other semi-arid crops and sheep husbandry. Sheep husbandry and fattening is relatively more practised and culturally important in Shallalah Saghirah than in Qarah. Large scale agriculture is present in Qarah but not in Shallalah Saghirah. Traditionally, Qarah cultivated its own potato species but this has disappeared since the last 20 years.

Qanat construction

Both qanats are of Byzantine origin. In Shallalah Saghirah, the spring-based qanat is strong, built in limestone hardrock. Most Byzantine casings were in good condition. In one airshaft, a new casing of 10 m. high had to be constructed using reinforced concrete. Furthermore the openings of the airshafts were protected with walls that were constructed around the airshafts covered by iron fences. The renovation resulted in a strong construction and will facilitate future maintenance.

The original construction of the qanats in Qarah is a handdug tunnel lined with stone masonry either in a fishbone pattern or stapled. In most of the water production sections of the tunnels, the walls are not lined with masonry and the qanat is dug into limestone hardrock. Some tunnels have collapsed, especially in the airshafts sections. Recent renovations done under supervision of the regional government have not been with great success. As a result, the contractors used concrete to line the whole qanat and did not consider the difference between the water production and transport section. A better communication between the qanat users and the government could have prevented such technical mistakes.

We observed in both qanats, but specifically in Shallalah Saghirah, an accumulation of scaling and crusts on the qanat walls, clogging the pores and blocking the infiltration of groundwater. This crust was removed during the renovations. Wilkinson (1977) explains that an dangerous cause of decreased flow could be deposition in areas of carbonate rocks; similarly the most frequent maintenance required for ancient Rome's water supply was the cleaning of encrusted channels.

Irrigation technology

Irrigation systems can be divided in two basic types; surface irrigation, either flood or furrow and pressure irrigation involving pipeline networks and eventual distribution to the crop via sprinkler or trickle/drip systems (Beaumont. 1993). In Shallalah Saghirah, the farmers use the traditional flood irrigation whilst in Qarah they use a variety of technologies. In some gardens in Qarah, farmers have built their own irrigation reservoir on their land to accumulate the amount of water they receive during their traditional turn. Attached to the reservoir is a diesel powered pump that pumps the water into a drip irrigation system to irrigate trees like olives, pistachio or pomegranate. We can see here a positive combination of the traditional resource allocation with mechanised water use efficiency. The government has started to subsidize drip irrigation systems to farmers and this example is a great encouragement that mechanisation does not necessarily mean the degeneration of qanats.

Physical infrastructure, energy & power

Shallalah Saghirah is relatively isolated with poor public transport, whilst Qarah is well connected with direct access to the main highway to Damascus. In Syria there is still a considerable difference between the urban and rural regions in terms of physical infrastructure (Zakarya, 2005). Qarah town centre and surroundings are connected to the national electricity grid whilst Shallalah Saghirah at the time of fieldwork did not have this connection. Electricity was provided by diesel powered generators and car batteries. This also explains the more dominating presence of the realm of modernity in Qarah than in Shallalah Saghirah. Interestingly Qarah has traditional windpower in the form of windmills built in the early 20th century. Some of these were still used for operating small wells and mills. At the end of fieldwork in Shallalah (2004) electricity was planned for Shallalah Saghirah. It is not known what kind of effect this had on the qanat use and renovation. It is expected to have a major impact on the livelihoods of the qanat users.

9.2.2 Socio-cultural elements

Orientation-to-action

We can see a dominance of self-regarding cooperation in Shallalah Saghirah. Throughout the renovation, the orientation to action shifted for some individuals from other-regarding cooperation to self-regarding cooperation and even to selfish individualism after the occurrence of an internal conflict. There was a level of community distrust and jealousy that had its history in the preceding years of disputes and power struggle between lineages. Due to poverty and distrust, the willingness of users to contribute either in kind or financially for the common good was not present. The pilot renovation was supported by external subsidies paying for materials and salaries. An attempt to donate a communal tractor to the community ended in a dispute about ownership and therefore was not granted. However, personal efforts of other-regarding co-operators within the community and conflict management procedures created a positive energy to develop a technically successful renovation. With the increased water flow after the renovation, olive trees have been planted in the communal garden. Moreover, the renovation attracted a Lebanese eco-tourism company that was interested in developing Shallalah Saghirah as a site. These developments could interest other users to invest in continuous maintenance of the qanat in future.

In Qarah the users of qanats already contributed an annual amount to pay salaries or costs for maintenance. If users could not pay, they are willing to help in kind in renovation works. This traditional system caused an institutionalised dominance of other-regarding cooperation. In reality the dominance was found in self-regarding cooperation. Through individual awareness raising using video communication, the community was mobilised to develop a community action. The renovation was partly subsidised by external parties and farmers have contributed to part of the finances. However the farmers' willingness to cooperate only came when the first positive effects on the flow of the qanat were noticeable. Although there are distinct differences in orientation to action we can identify some similarities. In both cases, the modernity has arrived in the form of self-regarding cooperation and opportunism aimed at financial gain. We can also see the importance of the individual effort of community members, what we have called the "initiators" serving as foundation for collective action. They start off with other-regarding cooperation to mobilise the community into collective action.

Power relationships and conflict management

Both the communities of Shallalah Saghirah and Qarah are based on traditional hierarchy consisting of unequal or asymmetrical power relations, where family status and affiliation with external powerful individuals are important bases for social power. In Shallalah Saghirah, the traditional group of irrigation right holders elected a local supervisor who was responsible for channelling the salary payments during the renovation. The payment procedure resulted in several disputes between workers. To prevent conflict, the local supervisor gave the responsibility of payment to a third party, the government representative. It eased the social tension. Lack of a village leader and a history of social conflicts, weakened the social organisation. There is distrust, gossip and jealousy among the users. During the pilot renovation, the workers' group split up in two factions and the work had to be halted. Conflict resolution was a difficult process without an internal negotiator and no recognition of the state as mediator.

In Qarah, the ultimate responsibility for all the qanats is with the mayor of the town. The traditional qanat committee mediates in case of disputes or conflicts between users. The social cohesion is strong through the presence of this leadership configuration that mediates and governs the qanats. In Shallalah Saghirah, the social conflict was eventually solved with the help of an external Bedouin judge. But disputes continued. The exit-option that some young families choose is to migrate to the urban areas to start a new life. The social cost of staying in the village with ongoing disputes is too high for them. Together with economic reasons for migration, this development disrupts the community cohesion.

Despite being the religious minority in Qarah, the monastic community exerts considerable power. This is based on historical ownership of most irrigation rights in 'Ayn al Taybeh qanat as well as educational background and access to communication with the wider world. Similar to Shallalah Saghirah, the power structures in Qarah are traditional and democracy in a "modern Western" sense is not present on community level. This is also due the wider political climate of Syria that is hierarchical. But the autocratic approach to collective action was beneficial to the peaceful and sustainable maintenance of the qanats. Due to the respect that the users had for the leadership there was no open dispute. Adversely, in Shallalah Saghirah, the respect for leadership of the elected supervisor was not fully observed; he experienced conflicting loyalties between the two factions. Therefore he did not have full social power to lead the collective action successfully. Moreover, due to the local importance of status, honour and public scrutiny, the introduction of transparency and equality with the use of participatory approaches caused a certain disruption of the existing power relationships leading to conflict.

Communication, knowledge, perception and worldview

Although there is considerable local knowledge about the current construction of the specific qanats, we observed that local users have no knowledge of the history and development of the technique of qanat building. There are specific experts such as the *natur, wakil, haqoun* and specialist farmers but their knowledge is minor compared to, for example, the *muqannis* of Iran[89]. Likewise in Oman, Wilkinson reported that the *Awamir* or falaj experts had less knowledge of the surveying methods and specialised constructional techniques than the Iranian experts (Wilkinson, 1977). For most users, the origin of the qanat is an attainment of Romans or God. In both Shallalah Saghirah and Qarah, the entry of mechanised technology changed users' worldviews. It also created miscommunication between the young and the old generations. Both case study sites are in a societal transition process. In Qarah, the access to modern communication technology and conventional scientific knowledge is better than in Shallalah Saghirah due to the proximity of the capital Damascus. Religion, family and social relationships dominate the worldview in both Qarah and Shallalah Saghirah. In Shallalah Saghirah we observed a higher incidence of fatalism than in Qarah. For some users in Shallalah Saghirah there was a strong sense of tribal affiliation and identity, regardless of whether they had travelled far outside the community or not. Identity is also determined by the relationship between the user and the wider political system in the country. This is linked to status and power; some users will use their affiliation to the political party as a basis whilst others tend to use tribal affiliation.

Resource allocation, governance, leadership and government support

Both qanats are communally owned and with traditional irrigation rights. According to the customary rules, the location points of access can be divided into three categories at both case study sites. The outlet for free drinking water *('ayn),* the canal for allocated domestic use *(saqieh)* and reservoir for irrigation water of which the rights based on inheritance laws or trading *(birkeh).* In both cases the qanat right holders are represented in a committee. Whilst Qarah has a longstanding and well-developed system

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[89] *Muqannis are specialist qanat builders in Iran, the birth place of qanat technology. They form a special class in society and are highly respected for their skills. The last qanat in Iran was approximately built in 1975 and then the practise was halted due to unsafe working conditions. An estimated 40 Muqannis are still alive in Iran. (Pers. comms. with muqannis, 2000; Beaumont, 1968,1971, 1989; Goblot, 1979; Wilkinson, 1977)*

of governance, the system of rights in Shallalah Saghirah is relatively young. Two other main differences are the tradability of rights and the procedure of allocation of irrigation water.

In Qarah, mostly likely due to the mixed religious history, Islamic inheritance laws do not dominate the rights system and the owner of a right is entitled to sell his land and water share to anyone outside of the extended family. Conversely, in Shallalah Saghirah, custom does not allow selling water rights to outsiders: the pre-condition for cooperation on joint water shares is that members of a family should marry endogamously (parallel-cousin marriages) *(cf.* Wilkinson, 1977). Although this is still largely the dominant custom in rural Syria, transformations in the wider society are changing the perception of young people on this pre-condition. The transformation resulted in disputes between the young and old about marriage customs. In Shallalah Saghirah, the act of offering a dwelling to an outside man married into the community caused internal conflict within the family.

The leadership at both sites is based on different local contexts. The leadership in Qarah is complex and embedded in its social history. Political and religious positions play a vital role. The monastery and its leader, have a form of historical symbolic capital, which enables them to exercise power and initiate qanat renovation. This is different in Shallalah Saghirah. The justification for leadership in Shallalah Saghirah is increasingly weak; a conflictual social history has weakened cohesion. Although the village elders officially govern the irrigation rights, there is confusion about who should be leading a qanat maintenance and renovation action. The community members currently differ in their view on what is or should be a justified leader for the village. As the village does not currently have a *mukhtar*, leadership continues to be problem in decision making on future qanat maintenance and renovation. Leadership in this respect is an overarching element in the sustainability for qanat maintenance.

The government support and institutional framework differ greatly between Qarah and Shallalah Saghirah. Qarah is not classified as a marginal area, its proximity to supporting government institutions helped in setting up a framework for qanat renovation. In fact, there already was an existing subsidy system for qanat rehabilitation in the region of Greater Damascus of which Qarah forms part. Shallalah Saghirah on the other hand is part of a marginal area called the Khanasser Valley. Agricultural production benefit (and thus increased income) from renovating a qanat cannot expect a great institutional and governmental investment framework. Aw-Hassan *et al.* (2004) compared agricultural production options in the Khanasser Valley with a similar marginal area in Yemen and concluded that lack of investment in rural institutions, services and

infrastructure limits the potential impact of production technology as poverty alleviation strategy. In these areas, the poor and those with limited land usually choose out-migration as an exit-option.

Furthermore, the division of particular roles in the allocation of water is more complex and elaborate in Qarah than in Shallalah Saghirah. In Qarah the *natur* plays a vital role in the daily allocation of irrigation water, a role that does not exist in the governance system in Shallalah Saghirah. The *natur* in Qarah is crucial in managing daily disputes.

Economy and markets

None of the case study sites are self-sufficient or based on household economies. Population growth and economical pull to the capital caused out-migration in Qarah. The possibility exists that the younger generation will not become familiar with traditional knowledge in order to maintain the qanats in the future.

Whilst migration for off-farm work has been taking place at both case study sites, the impact of the wider changing socio-economic situation was most felt in Shallalah Saghirah. Being a small village, the first wave of migration of lineages disrupted the family and marked the start of social disputes and changing power relations. Presently most of the income in Shallalah comes from off-farm work.

In Qarah, the users community started to be affected by economic and social migration when the majority of the Christian population left to countries abroad in the beginning of the 20th century. After the population explosion in the last decades, many families from Qarah sought work in services and government employment as opposed to farming. The latest migration of young families to urban areas led to a juxtaposition between the younger and older generations. Retired urban workers or elderly farmers now do most of the farming.

At both sites, ecological and economical calculations proved that qanat renovation is profitable in the long-term. The financial investment in renovation is relatively small compared to both the pure and multiplier benefits in the long-term.

Demography and water use

In both sites, local population growth has been exponential. A combination of a traditionally high birth rate and improved access to healthcare is the main cause. In both surrounding regions, this has reflected in over exploitation of the groundwater resources using diesel-operated pumps.

In Shallalah Saghirah, pumped wells are not directly influencing the groundwater level. The traditional law of "*harim*" is not implemented strongly and this could potentially form a problem whenever users start to

decide to drill a well close to the sources section. The renovation has safeguarded the supply of drinking and domestic water temporarily. It remains unclear for how long the supply is guaranteed but it is estimated that the supply will continue for at least 10 years. This is on the condition that boreholes will not be sunk near the sources section. But it is unlikely that pumped wells will be drilled in the near future. However, we have observed that social dispute can prevent access to the drinking water outlet for some users and will force them to drill for their own water supply. This will endanger the water supply.

In Qarah, the main recharge area for qanats is located on the Anti-Lebanon mountain range. The geological strata from which the qanats receive their water are quaternary deposits, which are part of the Anti-Lebanon mountain range. This results in a positive recharge with the occurrence of heavy snowfall in the Lebanese mountains. In the vicinity of Qarah, the karstic aquifers are not productive for the extensive use of pumpwells. A part of the recharge occurs in the area of Yabrud, 20 km south, where a severe groundwater drop caused by pumping has occurred (from 20 m. to 60 m. bsl. between 1950 and 1994). Overexploitation in the wider recharge area is most likely the main cause for the falling groundwater levels. To have a sustainable use of qanats in Qarah, regional control on the use of pumps is thus essential. In some cases of qanats in Qarah, recharge dams near the sources area of the qanat maintain the local groundwater level. Qanat users have also reacted on severe drops in qanat discharge by changing from cereal production (barley, wheat) to less water demanding horticulture (fruittrees). The introduction of piped water supply removed the dependence on qanats for drinking and domestic water use. However many users fetch qanat water for the preparation of tea; the water of two qanats is preferred due to taste.

In summary, we have used a human ecosystem approach to compare and analyse the various sociocultural and biophysical elements of a qanat system within the context of societal and biophysical transformations at the two sites of Shallalah Saghirah and Qarah. Shallalah Saghirah was initially considered as a homogeneous community using a qanat that is not threatened by pumping activities. However this site is not the most viable system due to endogenous dimensions of collective action that caused a lack of regular qanat maintenance. Moreover, the users are not willing to invest themselves in maintenance.

If we correlate the various elements against the other case study, we can see that the users in Qarah are more likely to keep maintaining their qanats than Shallalah Saghirah. The groundwater pumping is a serious concern in Qarah but the tunnel constructions are generally consistent, the social cohesion and leadership is strong, there is a clear ownership and the system of rights is agreed upon and deeply rooted in

the local community. Moreover, the users are willing to invest in renovation. They have also shown an adaptive capacity to implement new water saving irrigation technologies (drip irrigation) and change of crop patterns. This gives hope for the future, where a new scenario of green technologies can provide a sustainable use of qanats for local communities.

In the region of Qarah and the Awaj/Barada basin, regional policies are important regarding the management of groundwater resources. Current laws on groundwater use by farmers using boreholes are currently not effective. The existing well activities south of Qarah are to be monitored and controlled to prevent further depletion of the aquifer. Once this condition is met, qanats in Qarah can have a good future. In Shallalah Saghirah, ensuring the social and physical sustainability of renovation is complex. Although technically, the renovation was a success, socially the renovation had been not so successful.

Transformative processes such as the introduction of pumps industrialization, and landreform influenced the worldview of users and their subsequent orientation to action. Biophysical causes of abandonment such as drought or climate change are debatable however both a downward trend in rainfall and observations by farmers suggest this as a cause for abandonment. On the other hand, qanats have always experienced and survived long spells of drought and our data cannot possibly prove a link of abandonment with global climate change.

9.3 Energy input into the human ecosystem – collective action, mediator roles and external agency

Using a complex human ecosystem approach provides a useful structure for identifying the various specific contextual biotic and non-biotic elements of the qanat as a system. Qanat maintenance is a condition to keep the qanat as human ecosystem "alive". I consider collective action as "social energy" input into the human ecosystem through community participation and external agency. However, I found that a rigid ecosystem approach is less useful in the identification of influential events in local social histories and the importance of mediation and external agency. People do not live by static structures and symbols alone, and there is a need to describe specific adaptive processes in local human histories to more fully understand the context and origin of collective action (McNetting, 1974). For this a more process oriented analysis rather than a mechanical ecosystems' approach is better equipped. In our analysis of the two renovation cases as processes over time I found that initiation for qanat maintenance is complex. It depends on the various roles of

mediation that actors of collective action play as well as their powerbase and links to resources and authotiry.

During both renovation case studies, mediation and external agency to assist collective action took place. In development, external agency is a contentious concept; it can lead to donor led activities, dominance of supply driven dynamics, conditional aid to induce action and not respecting the autonomy of the group in need of development assistance (*cf.* Ellerman, 2005; Abraham & Platteau, 2004). We have observed in both cases that funders' conditions, administrative procedures and pressure for project delivery make it difficult to ensure complete ownership of the renovation. In Shallalah Saghirah we can say that there was less community ownership of the renovation than in Qarah. This is mainly due to the heavier leading role of external actors in the intervention in Shallalah Saghirah, supply driven dynamics for international organisations and the community perception of dependency towards the external actors such as the researchers, ICARDA and the funders. Conditions on how the funds should be used made some actors jealous and feel excluded. A natural reaction was to exercise pressure on the beneficiaries and if this was ineffective, to sabotage the project (*cf.* Abraham & Platteau, 2004).

More positively, in both cases, knowledge about qanats was made locally applicable and the intervention was done by the local doers of development (*cf.* Ellerman, 2005). Notwithstanding, external agency was requested by both communities and served as the external energy input to give impetus in maintaining the qanat as human ecosystem. The question is whether this impetus will be a one-off, inducing future maintenance carried out only with energy input from within, or if external agency will always be necessary to keep the qanat as human ecosystems alive?

To partly answer this question, it is useful to go back to management of qanats in ancient times and other countries. The continuous practice of qanat systems in ancient times suggests that the system was ecologically "balanced", due to a highly centralised, bureaucratic society devoted to a policy of water control and development of irrigated agriculture (Beaumont, 1993; Wittfogel, 1957). The number of officials involved in running qanats in Ancient Persia was considerable. During the Achaemenid Empire, carefully planned and managed systems of administration, land and water distribution, tax collection, communication and post backed the Iranian expansion of their empire and established a wide network of qanat settlements (Honari, 1989). Government offices were in charge of construction, digging and maintenance of qanats (*ibid.*). Similarly in Oman the use of qanats (falaj) prospered during the dynastic rule of the Imamates. Currently a specific *Directorate of Aflaj and Support Wells* has been established within the

Ministry of Water Resources to fund qanat maintenance requests from communities. It seems external agency either in the form of government support or external funders is a pre-condition for long term qanat renovation. However, the more the user community cooperates well and the less petty internal conflicts occur, the more likely is the success of this external impetus.

9.3.1 Cleaning a qanat; hierarchy, heterogeneity and benefits

Historically, a centralised and vertical nature of social organisation thus appears to be a good "enabling environment" for sustainable maintenance of irrigation systems like qanats. Abraham & Platteau highlight that in many tribal societies, a rigid hierarchy of ranks, based on age, gender and lineage dominates (Abraham & Platteau, 2004). In fact, one could reasonably ask whether hierarchy and "strong leadership" are not ways of coping with the potential conflict induced by water scarcity (*cf* McCay, 2002). Qanats could be seen as remains of the pre-industrial hydraulic empires described in Wittfogels' Oriental Despotism[90]. Wittfogel (1957) describes the series of military defeats that weakened the authority of Constantinople over the Turkish provinces where local masters were seeking to buttress their position; as a result bureaucratic and absentee landlordism prevailed until after WWII. This perpetuation of quasi-hydraulic patterns of society formed a positive enabling environment for qanat cleaning and maintenance governed by relatively independent village *shaykhs*, tribal leaders and rich families. Similar to Wittfogels' "hydraulic regimes", calendar making, astronomy and mathematics are still of utmost importance in the use of ancient qanat systems; sundials or water clocks have now been replaced by modern watches and allocation of water is done by carefully measuring and calculating the volumes for each user.

More recently, in the Sindh Province of Pakistan, Bandaragoda (1998) found that irrigation agriculture in Pakistan is believed to be having a strong hierarchical society[91]. Next to the hierarchical character,

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[90] *Oriental Despotism, a comparative study of total power, published in 1957, is a monumental study of the hydraulic patterns of northwest China, India, Turkestan, Mesopotamia, Egypt and Meso-America. Although heavily curtailed by McCarthy's sensors, Wittfogels' publication gives a good insight into the context in which qanats developed. According to Wittfogel hydraulic society is the outstanding case of societal stagnation. Lon Fuller (1965) has published a critique on Wittfogels' thesis.*

[91] *International Irrigation Management Institute (IIMI) pilot project "Farmer-Managed Irrigated Agriculture", which was implemented at*

the irrigation organization in Sindh tends to be closed, with certain mistrust towards outsiders. In a pilot research project on community based irrigation, the International Water Management Institute (IWMI) aimed to facilitate farmers' participation on all levels of rural society. IWMI's interventions were seen by some farmers, particularly those who had some vested interest in retaining the status quo, as part of a hidden agenda aided by international institutes (Bandaragoda, 1998). It appeared that rural societies are profoundly complex; farmers are of different distinct social groups with different sets of goals and objectives, and different alliances. Forces of tradition, such as feudalism, caste and biraderies have a greater influence over people's lives than the written codes of law (Bandaragoda, 1998).

Since Wittfogel, anthropologists have debated about the relationship between scale of irrigation systems and the complexity of management structures (Mabry, 1996). However there does noet seem to be a conclusive answer and to scalar stress such as water scarcity there are a number of organizational solutions which include or do not include social inequality and political complexity (Mabry, 1996). We can see in our two case studies that the larger scale of Qarah contributed to a more complex irrigation organisation than that of Shallalah Saghirah. However we cannot conclusively say that the community of Shallalah is less hierarchic than Qarah. In fact, although the group seems homogenous, local history reveals great social and economic differences between family members in the community of Shallalah Saghirah.

Many New Institutionalist scholars propose that equality and economic homogeneity are primary conditions for successful Community Based Natural Resource Management (CBNRM); in this view, heterogeneity and inequality are obstacles to overcome by the participatory development process (Dietz, Th. *et al,* 2002). However, the in-depth discussions show that the relationship between heterogeneity and collective action is complicated and further empirical evidence is needed to reach conclusions (Baland & Platteau, 1999; Bardhan & Dayton-Johnson, 2002). Latest insights on hierarchy and in particular the role of heterogeneity in collective action for environmental management are provided by the studies of Bardhan & Dayton-Johnson (2002), Somanathan *et al.* (2002), Kurian & Dietz (2003, 2004) and Adhikari & Lovett (2006). An actors' participation in collective action to maintain qanats can differ with the proximity of households to the local resource

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three different locations in the Left Bank Outfall Drain (LBOD) districts in the Sindh Province of Pakistan as part of the on-going IIMI research project, "Managing Irrigation for Environmentally Sustainable Agriculture in Pakistan"

base (*cf.* Adhikari & Lovett, 2006). Heterogeneity is difficult to isolate as key factor and conclusions on the relationship between group heterogeneity, leadership and power relations have been found to be far from clear-cut and highly depending on local situations (Kurian, 2003; Adhikari & Lovett, 2006). Although we have not used a Gini-coefficient to determine income inequality due our small sample size, we can say that both case study sites are economically relatively homogeneous. The qanat users group of Shallalah Saghirah is culturally (but not socio-economically) homogeneous whilst Qarah's group is culturally diverse and heterogeneous. In the case of Shallalah Saghirah, cultural homogeneity did not enhance collective action whilst in Qarah, collective action is more likely to be maintained. The long history of a property regime, maintenance, presence of respected leaders, mediators, initiators and asymmetrical power relations in Qarah were more important for the participation during the renovation than cultural heterogeneity.

Although most New Institutionalist research is mainly focused on economical heterogeneity (or "in-equality") the concept is wider and refers to a variety of differences between resource users. These include differences in landownership, wealth, education, access, caste, gender, ethnicity, power and political influence (Adhikari, 2002). We prefer to use the word heterogeneity instead of in-equality. Bardhan & Dayton-Johnson (2002) distinguish economic, social, cultural and ethnic variants of heterogeneity. They divide the research on heterogeneity in two camps: those who think heterogeneity plays a positive role and those who believe it plays a negative role. Their multivariate analysis of irrigation case studies in South-India, Central Mexico, Philippines, North Pakistan, Nepal suggests that economic heterogeneity has a negative impact on cooperation.

Somanathan *et al*. (2002) do not find any correlation between caste or ethnic heterogeneity and collective action on forest management in the Indian Himalayas. In their development of key measuring variables for heterogeneity Kurian & Dietz (2004) in India and Adhikari & Lovett (2006) in Nepal find that there is no straightforward impact of group heterogeneity on collective action for irrigation. They argue for a greater importance of contextualization and flexibility in governance to allow local adaptation of management regimes. Interestingly, except some brief mention of heterogeneity in Hoogesteger's study on Iran, none of the recent commons literature on relationships between culture, heterogeneity and collective action concerns a Middle Eastern context. This is surprising considering the current international involvement in this region. It calls for more understanding of the role multiple socio-cultural dimensions in local level processes in this region.

Tribal societies are not static and next to internal dimensions and institutional interventions like the Pakistan project, irrigation cultures are subject to other externalities and transformations of society. Later, in the 1960s, the digging of diesel-operated pumped wells was viewed as an indicator of social change. The new technology brought in from outside caused societal decentralization and individualism. The archaeologist David Thomas proposes that wells and well-related architecture can be considered as indicators of social complexity and behaviour. Where palatable surface water is limited, the digging of wells was one of the techniques developed to facilitate human existence (Thomas, 2000). This might explain why some qanats were abandoned as soon as new technology as an exit option was at hand. In those situations where qanats are still in use, a social tension is thus present; users can choose to dig wells, install diesel pumps and fend for themselves, thus turning against the "collective" and leaving the pre-industrial society, or stay within the hydraulic society and maintain the qanat collectively.

This brings us back to the daily realities of rural life in Syria and the "myth of communities". Most of rural Syrian villages are organized along a hierarchical structure where lineages and socio-political connections determine power relationships within the community. Abraham & Platteau point out that rather than an idyllic "village democracy" whose members interact in a free atmosphere of trustful cooperation, "tribal" societies appear as strongly structured entities based on powerful socialization processes. *"...Individual initiative and capital accumulation tend to be repressed, suspicions are continuously entertained about others' intentions, jealousies, rivalries and inter-personal conflicts are pervasive, and a rigid rank based hierarchical structure governs people's life"* (Abraham & Platteau, 2004).

To illustrate further local level processes we return to qanats as an example. In an ideal qanat system, the qanat tunnel is regularly maintained and cleaned. The continuation depends on social solidarity of user groups in a context of agrarian, social and ecological change and variable management arrangements (Vincent, 1995). Development of maintenance of a qanat also depends on how different households and individuals in the qanat community perceive the benefits of the collective action at any point in time. New Institutionalism looks at low transaction costs, financial gains and benefits as a prime motivator for collective action. This is however a narrow view on benefits, certain socio-political benefits also influence collective action.

For the community as a whole, several potential benefits of the cleaning of a *qanat* can be distinguished:

(1) The water may increase in quantity: all surplus gained through cleaning the qanat will be beneficial for the irrigation of the

community garden. This will mean increase of income and a more varied food supply.

(2) The water quality may improve: this would be beneficial for the overall health of the community, especially the members under 5 years of age.
(3) The restoration may help a long-term use of an environmentally sustainable system like *qanat*, therefore also increase the cultural heritage value.
(4) With the increase of cultural heritage value, the *qanat* can be an attraction for the development of eco-tourism and thus provide income for the community.
(5) The restoration effort can contribute to a certain "team building" and strengthen the social cohesion of the users' group.

Each of these benefits seems positive for the community as a whole. However individual households and actors may have a different perception with regard to the benefits. Collective action changes power relations within the community and for various non-economic reasons powerful individual households might not be willing to support the cleaning of a qanat, determined to keep the status quo ultimately leading to the decay of the system.

9.3.2 Initiators, leaders and mediation

We saw in the processes of the renovations that cultural homogeneity did not enhance collective action, more important were aspects of social history, the presence of leaders and "powerful" initiators and the existence of a long history of a common property regime. Whereas in Shallalah Saghirah there was an initiator but no leader, Qarah had both. Furthermore, communication and the sociopolitical and educational background of the initiators were important for successful initiation of collective action on maintenance of the qanat systems. Participation is linked to the presence of initiators, leaders and connectors in the power and equity landscape. Musch (2001) calls the initiators of collective action the "small Gods of participation" and we observed at both our case study sites that the presence of initiators is crucial. Chambers (2005) calls this the "primacy of the personal"; whether change is good or bad, it is determined by personal actions and whatever happens depends on those who are powerful. How conflicts can be avoided and cooperation achieved is the main focus of hydropolitics (Mollinga, 2001).

Kurian (2004) highlights the importance of historically defined power and social relations in the development of collective action at local level. In our case studies we saw that the power bases, educational background and social relations of initiators of collective action are vital

in the success and failure of the renovation. The recognition of the status of the main initiator of collective action in Qarah (the Mother of the Monastic community) helped in preventing conflict and creating consensus amongst the main actors about the course of the renovation. Initiators do not necessarily have to be rich and powerful, education and links with the outside world already provide conditions for other-regarding initiation of collective action. In Qarah, the initiator's power base was based on local history, her education, wide social network and political connections and the access to external agencies for funding. She had connections with powerful "*wasta's"* to exercise more than just *petty* mediation (*cf.* Rabo, 1986).

In Shallalah Saghirah, the power relations seem less asymmetrical, in a sense that the community exists of one patronymic descendant group. The initiator of collective action was historically a respected mediator within the group. However the respect of power of the main initiator changed during the course of collective action, in the end his own lineage did not recognise his power due to conflicting loyalties nested in a history of feuds between lineages. Naff (1994) identifies that there is a greater chance for increase of conflict where hostility is deep and intense and the actors are roughly equally powerful. In contrast, where actors are not equally powerful, emerging leadership can guide collective action successfully. A potential leadership in Shallalah Saghirah would be then from the side of the biggest irrigation water shareholders. However, paradoxically local history showed that the village leadership had originally been with the now smaller shareholders. The personal attributes of their lineage head of the past with regard to honour ("sharaf") and his political social network and power base with local Bedouin tribes had made him a natural leader of the village.

Compared to Qarah, irrigation water does not have a high economic value in Shallalah Saghirah and again the local socio-political history shows that there is a discrepancy between the narrow power base of the biggest shareholders compared to the wider political, tribal and urban network of the smaller shareholders. The smaller shareholders' dwellings were also closer to the drinking water access. Hence the real daily decision-making power is not with the biggest irrigation water shareholders but with those living closer to the resource and having the better leverage of *grand* mediation through socio-political connections. We see that with relatively symmetrical power relations where lack of leadership fails to manage disputes, as is the current situation in Shallalah Saghirah, it can result in conflict. Where external agencies introduce participatory techniques in these unequal power situations it can cause dangerous social disruption in local communities *(cf.* Chambers, 2005; Abraham & Platteau, 2004; Nelson & Wright, 1995).

9.3.3 Exit-options

Adhikari & Lovett (2006) found a possible relationship between exit options, as defined by outside earning opportunity and level of collective action. They found a higher degree of collective action associated with a lower average off-farm income. Both in Qarah and Shallalah Saghirah there is a relatively high percentage of off-farm income. We see that in Shallalah Saghirah the increasing presence of various exit-options has a negative impact on collective action. The explanation can be found in the local history where users conduct their own "social" cost-benefit analysis after conflict. The social costs of staying and resolving conflicts seemed to be too high for users to stay and collective maintain the qanat. Hence the out-migration of users imploded the system. In Qarah, the exit-option has both positive and negative effects; whilst the younger generation is pulled to urban areas for off-farm income generation, the older (retired) generation comes back to Qarah and invests their time and finances in repair and maintenance of qanats. Again, both case-studies show the importance of local situations and we deduce that there is no conclusive relationship between the presence of outside earning opportunites and collective action unless the context is taken into consideration.

9.3.4 Communication, perception and the use of video in participatory development

The case studies highlight the importance of communication and the different manners in which this process takes place for the development of collective action. The socio-political and educational background of initiators is crucial in the flow of information among the various actors. Local histories and social relations determine the perception of actors towards each other and the way in which they communicate with each other. Notions of shame ("*'ayb*") and honour ("*sharaf*") were important dimensions of communication during the collective action in Shallalah Saghirah. Gossip at community level seriously undermined the initiation and the course of collective action. On the other hand, it can also enhance collective action. The relationships between leadership, initiators, public scrutiny and formal and informal communication in a complex configuration of elements need further exploration and empirical evidence but our case studies suggest that these elements are crucial in a Middle Eastern context of collective action.

These qanat case studies show that the use of video to facilitate communication between actors was succesful. The footage that was used and screened to government representatives, policy makers and international donors, made them acutely aware about the issues in the field

and at the qanat sites. The use of video at local level greatly enhanced the initiation of collective action in Qarah. In Shallalah Saghirah it did not directly enhance collective action but was instrumental in conflict resolution. Particularly, the video feedback sessions in the village certainly eased the social tensions after the renovation. It created a sense of identity and self-esteem among the various actors of the collective action to reflect and watch themselves carrying out the renovation. The recent work of Nick and Chris Lunch in the use of Participatory Video (PV) in development projects (Lunch & Lunch, 2006) show the importance of video as a communication tool in empowerment and participation. The accessibility and versatility of the tool and the many useful applications that are still unexplored call for a greater future role of video technologies in the process of participatory development and research.

9.3.5 Collective action in a Middle Eastern context: *shirkeh dirkeh* and *sharaf*

The case studies of Shallalah Saghirah and Qarah prove the complexity of cooperation and response to challenges of survival in the harsh Syrian Desert climate. Water scarcity is the major ecological stress in the Middle East that provokes either conflict or cooperation (Hunt, 2004; Welch, 1996). Responses found throughout the Middle East vary from conflict (Israel/Palestine) to cooperation (building qanat systems). In his study to Moroccan irrigation systems Welch (1996) found that when hierarchical responses to survive scarcity fail, forms of deceit and conflict emerge and mediation is increasingly called upon. His four case studies show that water scarcity as major stress fosters both cooperation (*cf.* Qarah) and conflict (*cf.* Shallalah Saghirah) in irrigation systems.

Similarly, Molle *et al.* (2004) found in their study of a qanat village in Iran and its response to ecological stress that important lessons may be drawn. First one is the ingenuity of villagers to cope with scarce water resources namely by the development and maintenance of qanats (Molle *et al.,* 2004*)*. This is true for both Shallalah Saghirah and Qarah. Secondly, they identify a delicate balance between hydrological cycles and uses of water. The village of Jalalabad was heavily influenced by hydrological intervention such as the introduction of pump wells and building of the Khamiran dam (Molle *et al.,* 2004). Indeed, our case in Qarah shows a direct relation between the amount of drilling of wells and its proximity to the Ain al Taybeh. However, this did not lead to major conflicts yet. The role of individual leaders and their mediating power overrided the potential for conflict induced by hydrological intervention. On the other hand, Shallalah Saghirah did not prove to be influenced by

well drilling in the proximity of the qanat. Yet the internal social structure and local history proved that competition for resources led to a socio-hydrologic breakdown of the community.

New Institutionalism and group theorists led by Arthur Bentley state that where individuals have a common purpose and will economically benefit from cooperation, a group *will* form to cooperate for the common good (Gillinson, 2004). However, this is a rather narrow analysis of a complex process. The small family group of Shallalah Saghirah consisting of 122 people in the Syrian Desert did not develop collective action on their qanat system for over 50 years. As calculated, renovating a qanat would have been economically beneficial so other internal factors prevented cooperation between the users. In a Middle Eastern context, custom, tradition and notions of kinship patterns and social transformations shape participation and collective action. Personal relationships in the Middle East are cast in the language of family and tribe relations and understanding the elastic uses to which the term "family" is put is especially important in the case of rural Syria (Eickelman, 1978; Rabo, 1986; Rae, 2002).

Various frames of references and dimensions at local level such as cultural norms and values on honour, family ties, power dimensions, emotional states of actors, perceptions of status, historical developments, and human emotional, social and ancestral ties all influence the way people cooperate. Parallel to Pavao-Zuckerman's "multiple environments", McCay assumes a broader conception of institutions as major features of cultural, cognitive and ecological realms that surround and influence acting individuals and groups (McCay, 2002). These social complexities at micro-level could explain the absence of collective action at macro-level, where it is expected to happen from an economical New Institutionalist cost-benefit analysis. The social and cultural perception on what are costs and benefits for community members might be different.

With respect to Syrian society, two common proverbs that shed light on cultural dimensions of cooperation and collective action, are particularly interesting;

"*Shirkeh dirkeh*" = "cooperation is difficult"
"*Ana wa akhuyi illa ibn ami, wa ana wa ibn ami illa al ghariib*" = "me and my brother against my cousin and me and my cousin against the stranger"

These two proverbs imply firstly that cooperation is something exceptional and challenging and secondly is confined to family relationships only. The second proverb clearly relates to the segmentary theory often used by anthropologists to describe Middle Eastern tribal

societies. The principle of segmentation raises a basic question of European social philosophy-what are the minimal, or essential, conditions needed for individuals to cooperate in society in an orderly fashion? (Eickelman, 1989). True cooperation in the segmentary sense means that the individuals who decide to cooperate do this on the basis of full consensus and trust rather than on a democratic vote (*cf* Abraham & Platteau, 2004). The highest level of loyalty is found in close relatives and family allies. This is usually a small group. This makes wider cooperation difficult, as the first proverb states; the more individuals, the more different opinions to deal with, the more difficulties getting group consensus.

Above shows the necessity in the Middle East to first develop a high level of trust and loyalty between individuals before cooperation can start. A segmentary explanation of cooperation within society is based on a vertical, highly hierarchical structure, where the "tribe" is led by the notion of common descent and an honest, upright and truthful "leader"(Eickelman, 1989; Rae, 2002). Important in this sense is the central concept of "*sharaf"* – "honour, honesty"[92] related to the strength, cohesion and ability of a family/group to defend itself (Rabo, 1986). This seems to contradict Putnam's theory that "vertical" social capital cannot sustain trust and cooperation (Putnam, 1993, 2000); if un-coerced cooperation does happen based on segmentary principles, it can result in a long-term collective action such as qanat maintenance. However the lineage and extended family determine the level of cooperation in any given circumstance. Segments in society can be opposite when there is no external threat but as soon as an externality threatens one segment, segments can join and cooperate. The importance of trust and loyalty is clear in the second proverb where the family and tribe is the first group to be able to cooperate. Cooperation and collective action is temporarily and contextual.

9.3.6 Final thoughts and reflections on further research

Analysing elements of qanats as human ecosystems to contextualise collective action has been an ambitious exercise. It required combining both systems and process thinking. By identifying key biotic and non-biotic elements I have tried to place the collective action of qanat maintenance in a wider ecological context with specific reference to our Syrian case studies. However, I found, I struggled with the systematic approach as soon as I started to analyse processes of human adaptation to

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[92] *The honour of the family is often centred around the purity of its women but being "sherrif"(adj) is also part of the ideal of being an "Arab", living in harmony with God and men (Rabo, 1986)*

environmental and political change at micro-level. In this, Uphoff's orientation-to-action grid was instrumental to analyse perceptions and individual roles, as well as mediating processes during collective action. The seeming parallel between quantum physics, social energy and collective action is an interesting theoretical triangle that has yet to be explored. More case studies should be conducted to elaborate on this type of both-and analysis in the context of development intervention and collective action. In the context of development interventions more empirical emphasis should also be given to the relationship between collective action and specific processes of mediation and roles of individual actors, their linkages to (water) resources as well as local culture, power, leadership and authority.

Both "new" ecosystems approaches as well as New Institutionalist Economics (NIE) run the risk of being stagnant in systems thinking which may lead to policy "blueprinting" and generalisation for development intervention based on fixed, sometimes even ethnocentric, ideas of democracy, production and economic progress. For example, the introduction of Water User Association (WUA) concepts where legal repertoires, tradition and formal, for water rights are conflicting may lead to conflict at community level after, well-intended, external organisational intervention (Molle, 2004). Fully assessing local political context and social history is a requirement for understanding processes of collective action at micro-level. Moreover, the close connection between eco-hydrological systems and human organisation requires development workers and policy makers to re-think the application of prescribed intervention at whatever scale. Hydrological interventions such as the introduction of pump wells, building of dams and drilling deep wells will work, sometimes unintentionally, across scales and levels of social and political control and may lead to fatal impact to sustainable water extraction systems (Molle, 2004).

9.4 Conclusion

It has been identified that after the introduction of mechanised technologies in the 1960s, water scarcity and the strong competition for groundwater between borehole users and qanat communities accelerated the abandonment of qanats in Syria. With this study, I have tried to better understand collective maintenance of qanats as common property resource and evaluate the social, cultural, political and environmental factors that have driven abandonment and decay of qanats in Syria. By placing qanats in a development intervention context, my main research question was focused on the local level micro-dynamics and contexts. I looked at the main endogenous and exogenous factors influencing collective action for maintenance of traditional water supply systems called qanats at and

below community level in Syria.

The research questions were:

1) What is the status quo of groundwater resources and abandonment of qanats in Syria and how is this related to non-emergence of collective maintenance ?

2) How do socio-cultural transformations and processes at community level in selected case studies influence qanat use and maintenance?

3) What is the importance of history, perception, power and heterogeneity during selected case studies of qanat renovation?

4) Which various socio-cultural and biophysical elements of qanats as human ecosystems can be identified in relation to their use and maintenance ?

Chapter 4 of this study mainly concerned the first research question. Our national survey of qanats showed that 44 sites containing 101 qanats are still flowing in Syria. A general trend of abandonment is confirmed in our data. Biophysical causes for abandonment are found in silting up of calcareous deposits, earthquakes, floods and dropping groundwater levels. Sociocultural causes mainly lie in the adoption of new extraction technologies such as pumping, high rate of migration of users, lack of collective maintenance and the socio-political impact of Syria's landreform in 1958. Flowing qanats can be used as indicator for the presence of collective action at community level. Where qanats have dried up due to lowering groundwater tables, maintenance is often not resumed. However, I have also found that where groundwater tables are stable, such as in the case of Shallalah Saghirah, regular qanat maintenance can be low. Various endogenous factors were identified such as lack of social cohesion and events in social history that led to a lack of collective action for maintenance at community level.

The causes of abandonment are thus multi-dimensional and at national level we focused on the causal relationship between ownership, leadership and abandonment of qanats. A strong relationship between communal ownership and collective action is analysed. However, we also found that private and community ownership of qanats is not necessarily correlated to community leadership for collective maintenance. In many cases, the state is regarded as the main entitity to initiate and lead collective action on qanats. The unwillingness to invest in maintenance is strongly related to the lack of collective action. A dry qanat or silted-up

with calcareous deposits does not trigger collective action of the users community. There seems to be a "dismissal of human agency" in the local perception on the causes of the drying of qanats. In those communities where there is no willingness to pay, people rely heavily on state authorities and leave the maintenance to fate.

Chapters 5,6,7 and 8 of this book elaborated on the backgrounds, socio-cultural transformations and processes at community level of the selected case studies of qanat renovation in respectively Shallalah Saghirah and Qarah. The importance of history, perception, power and heterogeneity was also considered during these case studies.

In Shallalah Saghirah we found a small users group of 25 households that lives without electricity, asphalt road and relies solely on a qanat for water supply. Despite their village being remote, the community is widely linked to the outside world through migration patterns. Social structures at the site follow the principle of segmentation and are determined by blood relationship and marriage alliances. One of the main historical social dynamics is a continuous power struggle between two resident lineages. This originates from a fraternal competition for resources and leadership. This struggle hampered the emergence of collective action for qanat maintenance. We identified three strategies that users devise to keep their power base in the community; migration to urban areas, retaining and reviving tribal affiliations with the higher echelons of the Hariri clan in the Hauran or searching for internal marriage alliances and conduct seasonal migration or off-farm work. Using Uphoff's orientation-to-action grid, several main actors during qanat renovation were identified and plotted against the grid. During the renovation, it was clear how strong the events in social history and the existing power structures determined the success of the collective action for maintenance. Hydrologically, the renovation was successful. Our economic cost-benefit analysis also shows the renovation as an effective investment. However, both the positive economic analysis and the successful technical and hydrological outcome do not outweigh the negative social analysis. In a seemingly homogenous, small and coherent unit, context and local socio-political history played a determining role in the non-emergence of collective action for maintenance of qanats.

Qarah lies in a low rainfall zone, the community has an active cleaning history and a reasonable hydrogeological chance for successful renovation and social cohesion of the community. The town has a population size of approximately 19,000 permanent households of which 900 extended households have qanat user rights. Since 1986, it has a main asphalt road, electricity and piped water supply. We studied five qanats and their user communities. The qanat called 'Ayn al Taybeh had dramatically diminished in flow in 2002. Three strategies adopted by

farmers to cope with diminishing discharges of qanats have been identified. Change of cropping patterns from cereals to horticulture, application of different irrigation methods such as the use of buckets or drip irrigation and finally sale of the land without water rights. Due to the active investment attitudes and the long history of social organisation, the prospects for renovation were considered positive.

The renovation of qanat 'Ayn al Taybeh can be summarised as a successful qanat renovation both technologically and socially. A total of seven main actors have been identified. An analysis is provided of the various power relationships between the monastic community and the other main actors during the renovation. However we have observed that despite the projected benefits, spontaneous collective action did not take place previously. It only started with an energetic initiator, the use of video feedback and involvement of a third party, namely the international funders. Following cultural theory, the lack of spontaneous collective action without involvement of a third party can thus be explained. We observed that fatalism and an attitude of laisser-faire of the user community hampered the initiative to develop collective action spontaneously. Similar to the case of Shallalah Saghirah, it took a considerable energetic and committed initiator inside the community to start up the collective action. The main difference was that in Shallalah Saghirah the main community initiator did not have a solid power base for leadership whilst in Qarah the initiator did have an undisputed powerbase. Therefore the collective action in Qarah succeeded socially as well. However there is a high tendency and risk that the younger generation will move indefinitely towards urban areas especially Damascus. Furthermore the development of deep boreholes in the region is threatening the qanats of Qarah.

Using a complex human ecosystems approach endogenous and exogenous factors that influence collective action for maintenance of traditional water supply systems called qanats are divided in biophysical and sociocultural elements;

Biophysical:
Geology, morphology and soil; climate and rainfall, water quality and quantity; vegetation and agriculture; tunnel construction; irrigation methods; infrastructure and energy power

Socio-cultural:
Orientation-to-action; power-relations; conflict management; communication; knowledge; worldview; resource allocation; governance; government support; economy/market; demography and qanat use.

At both local and national level endogenous socio-cultural elements have a profound influence on the main condition for qanat sustainability; the continuous collective maintenance of the tunnel construction. The higher regional level human ecosystem shows that borehole users and qanat users compete for the same resource and a cause for drying up of qanats can be found in borehole users unsustainably draining the aquifers. Although many farmers attribute the drying up of qanats to "fate" or changes in climate and rainfall, it is more likely that transformation in the socio-cultural elements are main causes for the drying up and abandonment of qanats.

The human ecosystem approach has been useful to identify various biophysical and socio-cultural elements and relations of the qanat system, but we found the approach has a problem when attempting to translate it into local level processes and policy. The use of a human ecosystems approach means that the boundaries are fuzzy. In an attempt to bring focus in a systematic structure, it tends to fall into the same trap of forming "design principles" just like the recipes for devolution programmes in New Institutionalism. The approach also failed to analyse adequately the internal collective action processes that took place during the renovation case studies in Shallalah Saghirah and Qarah. The human ecosystems approach cannot account for the temporal analysis of specific local social histories. A process approach is more useful for this. Uphoff's orientation-to-action grid (1996) proved to be instrumental for this type of micro-analysis.

The two case studies of qanat renovation in Shallalah Saghirah and Qarah show that where maintenance is expected; a small and seemingly cohesive user community and no influence from nearby pumping activities in Shallalah Saghirah, the outcome not necessarily means successful renovation in social terms. The renovation of Shallalah Saghirah has shown the intimate power dimensions, multiplicity and heterogeneity of seemingly coherent, homogeneous and close-knit community. In Qarah, where the biophysical conditions are more challenging and the drinking water necessity is not present due to piped water supply, the outcome for successful renovation in social terms is more positive than in Shallalah Saghirah. One of the main factors identified for successful collective action for qanat renovation is the presence of powerful leaders, connectors and initiators at community level. History, perception, and power are important aspects of collective action for qanat maintenance. We saw in both cases that these factors are main influences on the process of community-based interventions. We did not find an unambiguous relationship between heterogeneity and qanat maintenance but whereas the community of Shallalah Saghirah was

culturally homogenous, the more heterogeneous community of Qarah was more successful in qanat renovation.

Although qanat renovation itself cannot solve the overall water scarcity in Syria, qanat technology and the maintenance of its systems can play an important part in demand management of this most precious natural resource of Syria. Hydrologic interventions will work and impact across scales and levels in a multilevel hydro-socio-ecological cycle. Renovation efforts of qanats in Syria should thus not only be focused on technical successes but take into account the much more important social and non-economical elements of the qanat as a human ecosystem such as power relations, the presence of initiators and social cohesion to guarantee social sustainability of collective maintenance. We have identified that third party involvement and external agency is crucial in the successful renovation of qanats in Syria. We found a discrepancy between the priorities of the government policies on water management and qanat maintenance. The only region where the Syrian government paid some attention to qanat maintenance is the Damascus countryside in the Barada/Awaj Basin. However, to save the remaining qanats and their communities in Syria, an integrated national effort involving the qanat communities, regional and national government departments can only guarantee future existence of the systems. This involves synchronisation of the development and proper implementation of laws on well drilling, infrastructure and cultural heritage protection as well as the protection of the shared aquifers between qanat users and borehole users. An integrated water management approach in Syria should therefore involve qanat communities and their leaders from the on-set. The institutional reform of water departments that started in 2006 gives hope that the Syrian government is now focusing more on overall integrated demand management.