Rainwater harvesting cisterns and local water management;

A qualitative geographical / socio-anthropological case study and ethnographic description from the districts of Hajja, Mabyan and Shiris, Governorate of Hajja, Yemen

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Foreword

If I could choose only one important thing to say to the readers of this thesis, it would be to raise a warning about the situation in the field area with a large part of the population living under extreme poverty and horrific living conditions.

Acknowledgements

I want first and foremost to express my sincere gratitude for the exceptional generosity of the Yemeni people. I hope Yemenis in Norway can be treated the same way.

I would like to thank Statens Lånekasse[1], BKK[2] and the Centre for Environment and Resource Studies at the University of Bergen for financial support of the project.

A wide range of informants in the field area have taken their time and effort to show me around and explain different aspects of the water issues. I will not list all names, but I wish to thank them all still hope those involved can be proud of their contribution. For practical help during fieldwork I would especially thank Matthias Leibbrand and Faris al-Aliyyi for letting me use their friends and contacts. Without these people and their networks the fieldwork could not have been done. Furthermore, Hussayn Mathqal, ôAbd al-Qawi Hajib and éAmin al-ôAbbasi for their everlasting hospitality and Yasir Mutiô for also assisting in field.

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[1] The Norwegian State Educational Loan Fund

[2] BKK is a regional electricity company

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Abstract

The thesis provides a qualitative geographical/socio-anthropological case study and ethnographic description of rainwater harvesting cisterns and their role in local water management. The analysed data is presented in a generalised form regarding the situation in the districts of Hajja, Mabyan and Shiris, Governorate of Hajja, Republic of Yemen. Water quality and quantity are both of an inferior and problematic character. The thesis looks into some of the causes behind this situation by using a rational actor's model to identify the main aspects of the eco-technical, social and cultural constraints that surround the actor as a framework regarding local water management. Different aspects of the water related local knowledge have also been focused on, in order to better understand the actor's situation of choice. The field area has undergone significant changes during the last 35 years, but the traditional way of managing water is still very much present, despite or because of the changes.

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Conventions and abbreviations

1. Personal names of informants have been left out or anonymized.
2. Transliteration key is given as an appendix.
3. Personal communication is not listed in the bibliography.
4. Quotation marks are sometimes used to indicate that a term is not to be understood by its usual narrow lexical meaning, but that reflexivity lies behind the use.
5. The font JAIS TTW is necessary to read the transliterated words if the file is opened in word: see www.uib.no/jais/jais

Abbreviations

GO	Governmental organisation
HD	Hajja dialect
masl	Metres above sea level
NGO	Non governmental organisation
pl	Plural
SA	Standard Arabic
sing	Singular
USD	US Dollar
YR	Yemeni Riyal (the exchange rate is circa 100 USD = 19,000 YR)

Part 1

Introduction, theory and method

1.1 Introduction

The topic of rainwater harvesting cisterns, and especially traditional rural domestic water supply in Yemen, has not been much dealt with in western academic literature. Most of the focus in water issues in recent time water related research has been about the declining state of the aquifers in the central highlands, but little has been written about rural small scale management systems and how they have changed in modern times. In Yemeni academic literature, there is very little focus on modern social science perspectives in small scale water management.

In this thesis I will focus on an ethnography of the traditional rainwater harvesting cisterns in the field area, but also see how they are connected to today's wider local water management. I will map different local strategies for water supply and also look into what types of continuity can be found in the local water management, and in which ways the local water management has changed. The role of local knowledge will be investigated together with an actor's model of choice, where identifying the framework of possibilities and constraints that surround the actor will be mapped.

The field area is located in the fertile densely populated western mountains of Yemen. The area is still characterized by a very autonomous rule concerning local issues, hereunder water supply. During the relatively short time of modern development, i.e. since the beginning of the 70's, a very high population increase has taken place and a grave situation of extreme poverty and unemployment causes the local water management to still be performed in a most unsatisfactory way concerning both quality and quantity of the supplied water. To understand the frames of the management observed locally today, I will argue that one has to look at the near traditional past and also to include practical issues, social organisation and cultural

factors. Water management is a political topic even at the very local level and far too often, this dimension is for various reasons, left out of water development literature produced by GOs and NGOs.

The local dimension is often lost to generalisation and rhetoric of policies, and the information and reality produced is far too often not in correlation with facts on the ground. I will argue that in order to understand the "water situation", one has to study the actions and ideas of those who actually perform it. In the field area, water is supplied, managed and used by the locals themselves, using local techniques and local knowledge. It is important to acknowledge the locals as conscious[3] decision makers that on an aggregate level, to a high degree, affect their own eco-technical, social and cultural[4] frames.

If the concept of "community participation" in the development sector or applied social science can ever be more than a slogan, much knowledge is needed about how local water management is undertaken. I hope this thesis can show the necessity of this, however complex it may be.

A full ethnographic account of the phenomena has not been possible to undertake due to the time limits of the project. I have chosen to focus on the rainwater harvesting cisterns and tried to go sufficiently into depth when it comes to how they function in detail. The present eco-technical, social and cultural context is very important and so is the change that the centuries old "tool-kit of water harvesting technology" has undergone during the relatively short time span of modern development.

Structure of the thesis

The research questions have changed throughout the fieldwork due to the explorative nature of the study and all the practical challenges and unpredictability. Under the umbrella *local water management* I try to first identify different important factors in the local water management and thereafter to explore some of their relations and further analyze some of

[3] A clarification of the term *conscious* is given on page 10.

[4] For clarifications of the terms *eco-technical*, *social* and *cultural* see page 8.

their causal connections. The effort of the thesis, however, lies not in theory or analysis, but presenting how complicated and interconnected a topic like local water management might be. This is done by looking into the following:

1. What can be found of local water management in the field area and how is it performed?
2. What are the eco-technical, social and cultural possibilities and constraints in local water management? How do these possibilities and constraints affect each other?
3. What is the present day role of rainwater harvesting in local water management?
4. What forms of local knowledge are the locals using in their water management and how is this knowledge connected to the possibilities and constraints in the water management?
5. Why is the water management regime continuing to exist and how are new factors incorporated? What is the balance between continuity and change?

Secondly, the presentation of the theoretical perspective and methods is given in part 1.The actual structuring of the data into chapters will follow the main theoretical Barthian model (see page 9) from eco-technical possibilities and constraints (part 2), to social organisation to cultural factors (part 3). For the presentations sake, the first start to introduce and focus on a general description of context, and especially of eco-technical factors. Part three raises some of the details from part two in depth and discusses these using newly introduced data of social and cultural character. Thirdly, sometimes the structural delimitation of a chapter has been chosen because of its strength as a “unit”, for instance the description of the traditional lime plaster, qadad. However the same chapter will have pointers to theory, methods, and other chapters.

1.2 How to conceptualize and theorize “local water management”

The theory chapter has two purposes:

1. An introduction to the main theoretical perspectives used in the thesis.
2. Focus on how we universally can conceptualize local water management, and thus discuss and reflect on a more abstract and general level, not necessarily in relation to the specific data from the field area.

The theoretical discussion forms a basis for how to understand the complexity that the real world represents. The process of looking at local water management theory has gone parallel to the rest of the research and in one way constitutes a topic of its own. However, in the final thesis, the presentation and analysis of the data have needed this basic, almost philosophic basis, focusing on how we can know something about local water management on a general universal level. There is an ambiguity here; theory for the sake of explaining the data, and theory that in itself is scientifically legitimate, interesting and valid, because of its support by numerous other scholastic efforts in trying to understand their data about local water management. In my view both are needed.

Why theory of *local* water management?

Despite lacking an exact delimitation, the term *local* is important regarding water management as *local* points to the main difference of water management between the developed and developing world, namely that much of the water management in the developing world is performed locally and is often very different technologically, organisationally and culturally compared to water management in the developed world. Due to these differences, one has to be careful when analysing water management with western concepts and categories. In describing and analyzing water management that is not performed by scientists and bureaucrats, such as often is the case in the developing world, great care needs to be taken not to impose categories and concepts onto the analysis that do not actually exist. It is necessary in my opinion, to have theory that is able to take into account variables in

nature, technology, social organisation and culture at the same time. This is often taken for granted in description and analysis of water management in the expert-run bureaucratic developed world.

Abstaining from defining exactly what the term *local* in *local water management* means, there is still a need to clarify this term: I mean here non-governmental, non-expert, non-elite and non-academic. In this thesis, the term has also meant rural, but it certainly does not have to carry this limitation. It points to a level of normality and commonness that makes *local* include far more than the previously much used concept *indigenous*.

City dwellers and even an *expert* may ride a bicycle in the same way as people in the countryside do. The knowledge of how to use a bicycle is somehow normally distributed among all these categories of people. However at the hands of the bicycle repairer, we see an expert in his specific field. This analogy highlights that experts are specialists in a certain field, or type of knowledge, or they are experts because of their position in a social network. Thus what I mean by *local* in *local water management*, simply implies that the management of the cisterns is done by the local inhabitants themselves and not by water experts in hygiene or engineering or any other outside influence. Another connotation is *common*, and the term *community management* is often used in the development sector. One argument for not using this term is the view of "the community" as an apolitical social mass and this perspective is according to my opinion not clarifying. Water is and will be political, even at the lowest level of analysis and should be approached accordingly.

The term *local* does carry some aspects of delimitation. However, it should be noted that this delimitation does not have to be geographical. It may follow completely other factors such as kinship networks, or even special social groups such as the traditional travelling "Well-cleaner specialists" mentioned later in the thesis. The delimitation can thus be related to technology, social or cultural groups, economical or even productional activity. In my view, it is important that the term *local* should not be tied to geographical location alone.

If *local* can be seen as something delimited, the term should still be open to analysis, on not only a micro level, but also in relation to large scale structural processes. Øystein LaBianca (1990) illustrates how local knowledge is, in a complex way, affected in the long term by the coming and going of civilisations throughout history in present day Jordan. Scale in this

perspective becomes a factor that shows how the concept of *local* cannot be analysed without its position in relation to other large scale processes in the society. *Local* is thus not only small scale but actually has various (potential) connections to other levels concerning scale in the analysis.

Academia and the development sector

Seeing a white thematic spot on a map, going in to do a single survey and coming up with a satisfactory comprehensive "answer" is of course an illusion. It is merely a step in a larger process. However, both the academic community and even the development sector are often faced with this situation and having a theoretical and methodological "toolkit" is very important. The academic community and the development sector have overlapping human resources since the topic of development is often the same, but both the overall final goal of the research and the methods used, are often very different. The data and knowledge produced in the development sector is often fragmented, based on swift "base-line surveys" where both the categories and even causality are taken for granted. It is also an important point that the results of such studies have to "please the system" in order to produce future income and sustainability for the companies and organisations. Here, academia, may offer an important correction, that can be utilized by whoever wants to contest the "truths" in the development sector, by auditing the reality produced, and offering alternative ways of understanding the world. In many third world countries academic knowledge, especially social science, is sacrificed for the sake of political comfort and even in our part of the world, the foreign ministries and the development sector, to a large extent, have a monopoly of presenting what is going on in distant lying regions.

Ontology of "water" and "management"

Man's interaction with nature and the utilization of natural resources has for a long time been one of the important topics in Geography and Anthropology. Especially Geography has been called an inter-disciplinary and a synthetic discipline, and it draws its ontology and theories from both natural and social sciences. However, also several directions in Anthropology also recognize eco-technical aspects as an important "frame" in which humans live and interact.

Theories come and go, and different traditions may have quite similar theories just with different focuses or different perspectives. Human ecology, political ecology, the niche-concept, integrated natural resource management, these are just some of them.

It seems fairly agreed upon in the wider academic world that the study of *natural resource management*, should include the ontological realms of both nature and society. There are many definitions of *natural resource management*, a concept in which *water management* can be placed, but most of them recognize that there are forces of *agency* that operate within a certain *structure* or *framework of possibilities and constraints.*

The imperative to relate first and foremost to the surroundings or physical reality is supported by many[5] and analysis of resource management in general, has to be done with an epistemology that includes "a real world" with certain fixed physical properties. This does not indicate that humans cannot alter natural frames, but even a cultural analysis must include some "hard science". This leads to the role of realism and naturalism in social science and in resource management one has to take an epistemological stand that includes both a real world and one that is socially constructed.

The "framework of possibilities and constraints" (Varisco 1982a) that the actor operates within, can be divided in many ways according to different theoretical perspectives and seem to vary in time and between scientific disciplines. However, most seem to recognize that there are both natural and human-made possibilities and constraints. From this point on, defining what is *natural* and what is *human-made* seems to be more problematic; as nature is affected and altered by humans, and humans have to operate within the physical reality of nature, and thus humans have to adapt to nature. Or as Daniel Varisco writes: "potential and constraints in those resources" (Varisco 1982a:42).

Humans also partially modify the physical or eco-technical "possibilities and constraints of the resource", for instance by making a diversion canal and thus making water available at height where it did not previously reach. If the canal is gravity fed, the water cannot run upwards and a new limit is reached. However, if the technology of pumping and pipes

[5] In this thesis emphasized by the anthropologists Barth and Varisco.

becomes available, suddenly, the previous physical limitation no longer represents a barrier. The laws of physics have not changed, it is rather human potential that has altered the physical limitations of water management by invention or innovation. Hence, technology and techniques have one component of physical possibilities and constraints, and another component of socio-cultural factors, and these two cannot be separated as theoretical categories without focusing on the internal connections. Through action, and interaction, humans can alter their technology. In this paragraph the term *eco-technical* was used rather than the term *nature*; as indicated further down, *eco-technical* is a better term to use as it is less laden with connotations of normative values. Human's interaction with their surroundings and exploitation of resources is closely connected to the technology and techniques they use: If a resource is not exploitable because the technology for some reason is not available, the resource does not represent a valuable source. The cultural connection between resource *management* and *technology* is an important issue. It is enough to mention many that well known food taboos are not functionally necessary. The cultural construction of what constitutes a resource can thus be very different from say economical mechanisms that are often more easily recognized; if water is plentiful and never scarce, it is simply not valued in the same way.

The term *eco-technical* is not used conventionally and coherently in social science, but I will argue that in relation to the model presented below, the term is well suited for describing and analyzing the "practical" sides of local water management. By connecting *eco-technical* to *possibilities and constraints* I will maintain that it can cover the term earlier called "nature". *Eco* gives connotations to system theories and the theories of human ecology within anthropology and *techno* gives connotations to the actual material-practical utilization of natural resources, eliminating some of the determinism and reification of the human surroundings. The split between the humans and their surroundings is thus avoided as it makes possible analyses where humans adapt to, and become part of, their surroundings. Actually, the metaphor *adaptation* was drawn from biology by Julian Steward, one of the founders of Cultural Anthropology in USA. He was also very early to focusing on *process* and incorporating the factor of *change* into theories. Later, Barth also took a concept from biology, namely the *niche* (Barth 1994a). *Eco-technical* also gives connotations to cultural landscape as a term that points to human interaction with their environment.

It is common in western Anthropology to differentiate between *social organisation* and *culture*. Very simply, one may say that culture refers to common ideas whereas social organisation refers to how social interaction is institutionalized both formally and informally.

I this thesis, c*ulture* is used in accordance with Geertz' (1993) ideas: "A model for and of "reality" leading the reader to think of shared ideas that can also be manifested materially as mentioned by Hutchins (1995). The concept of local knowledge (treated below) is situated in culture but also has strong connections to eco-technical and social factors. *Culture* is also a beneficial concept when discussing communication and meanings. To be able to communicate one needs not only language but also concepts and ideas that are somehow common.

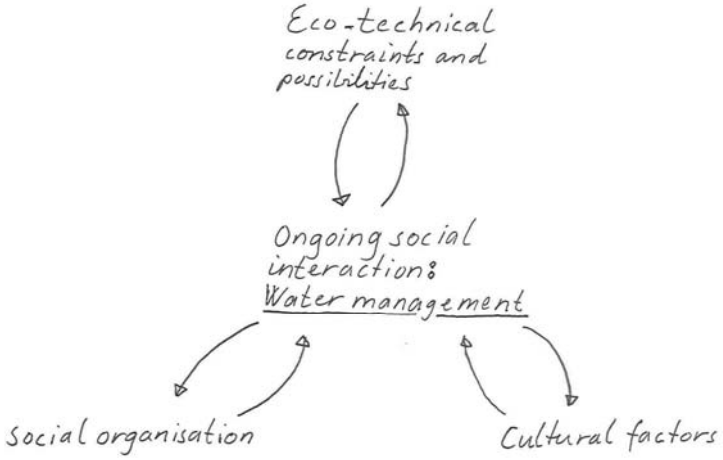

Fig. 1 This is a main model for this thesis for analysis of local water management. It is based on the ideas of Fredrik Barth (1994a).

In the theoretical perspective of this thesis, water management is seen as an ongoing action inside the above mentioned framework and this perspective is borrowed from the anthropologist Fredrik Barth (1994a). It should be commented here that Barth's theories are not new; in the 60's and 70's they were a criticism of earlier structure-functionalistic and more static models of society that did not take sufficiently into account continuity and change. His theories are developed from several of his contemporaries: Goffman, Firth, Morgenstern & Neumann, Gluckman and several others. Later, during the height of the post-modernism era he formulated criticism against the scientific vagueness that characterized parts of this tradition and is seen by some scholars as being too "objectivist".

The main importance of the model in fig.1 is the lack of connections between the different factors lying around the ongoing social interaction. Obviously, the simplicity is striking compared to many other models, including others of Barth where there is a criss-crossing of connections and concepts. Many of those models are semi-systemic in the way they incorporate arrows that show what produces effects on what. This model's main point is derived from Barth's perspective that it is humans that maintain and sometimes change their own framework, and as the three around-lying dimensions affect each other, this will happen only through social interaction. The around lying framework has "feedback loops" that go into the focal point: Social interaction. This introduces a very process-oriented perspective that has the ability to account for change and complexity.

Barth focuses the *actor* looking at his surrounding framework around himself, making his more or less conscious and rational choices, that together with other actors, through social interaction, generate framework and social structures (Barth 1994c:18). Barth was among the first to oppose the view that a society was one delimited entity, rather, seeing it as a process. The direction he and his followers represent in Social Anthropology have to a large extent focused on resource management in "exotic" parts of the world and have produced sound concepts and theoretical perspectives that can be most useful when transferred to the topic of water in third world countries. But his many academic works form Norway, also make him a good theorist in the respect of looking at *local* as not necessarily exotic and culturally distant.

Criticism of Barth has largely followed the trail that the average actor is not only an opportunist that immediately would change his behaviour according to what would benefit him at the moment. Barth answers this critique by showing to altruism as also being a motive or value for the individual. Indeed, *values* may also be of cultural character, and thus even "life after death" may be an important motive. This also includes religion and ethic views of the individual. According to Barth, value maximizing behaviour includes far more than short sighted economical profit.

Further, the critique points to the role of power, knowledge and to what degree the actor is "trapped" by his own culture and perception of the world around him. Is man always acting consciously? Other scholars would put greater emphasis on concepts and processes that limits the actor's choices, such as culture, power, authenticity, knowledge and norms. But Barth

does not refuse the significance of these frames on the actor, but merely turns it the other way around: The actors, through daily social interaction, maintain and sometimes change their own social structures. The social structures would not have existed without humans interacting together. Authority and legitimacy are not there by themselves, they are there in force by someone who acts, and uses the potential set of symbols available. The "landscape" of social and cultural factors is just as "real" and constraining as eco-technical factors. The locals cannot just throw away all their old social and cultural frames and adopt for instance a westernized democracy or bureaucratic water management.

An actor's model is based on some degree of rationality and consciousness. By *conscious*, I am here referring to Gilje and Grimen's (1993) use of the concept of "the principle of charitableness"[6] . They state that the researcher has to presuppose that the actor is rational in his choices and actions unless irrationality would the only possible explanation. This forces the researcher to be open to the idea that the locals have other values and senses of right and wrong, and that analyzing "rationality" has to be done with the locals own categories and perceptions of the world, rather than judging the behaviour as irrational. This does not mean that all forms of culture or local knowledge have to be completely coherent. Self contradictions do exist on an aggregate level, but it cannot be concluded from this that the locals therefore *are* irrational. Rationality seems to have limits relating to belief system, culture and knowledge. Relativism is a problematic result of such thinking and is much discussed in social sciences, but it does warn us about the pitfall to judge others' actions as irrational according to our standards (ibid).

Varisco (1982a) states that:

"such a model (a rational choice model), has the potential for simulation or prediction, since it defines how an actor should act rather than saying how particular actors at a particular time have acted" (ibid:63)

Further, he argues that such models do have limitations as empirical cases such as e.g., an ecosystem that is very complicated, and also that actors do sometimes make "mistakes". They do not always make the "right choice".

[6] "Barmhjertighetsprinsippet"

"Individuals often have the freedom to make wrong choices and survive." (ibid:63)

Actors at the individual level in water management may have different agendas than the "group" for instance at village level. Hence the different levels of scale should be taken into consideration in an analysis (ibid:62)

Barth does take into account the discrepancy between the individual's action and action on an aggregate level, and argues that although it is the individuals that produce the "framework", it is shaped by the sum of all the individuals. "Environmental degradation" can be an example of such an *aggregate consequence*. This dimension is important as different individuals, groups and sub groups are often interlocked in social interaction. The Barthian model in fig. 1 has social interaction as a focal point, but seeing different actors at different levels and scales at the same time is of course a theoretical simplification. One important point here is that water management is not performed by individual actors alone, acting consciously, but in cooperation with others. And, in cases of private, single individual water management, individual actors still have to "navigate" through the possibilities and constraints that other actors maintain and produce.

By looking at *transaction of values*, one can analyse not only economical circulation, but also other types of circulation of "values" that are meaningful to the actors as mentioned above. His models of such activity in Jebel Marra, western Darfur, Sudan (Barth 1967e) shows an intricate model of value circulation incorporating realms of both economy and wider cultural values. The point here is that knowledge is an important part of value maximizing activity that and the concept of (local) knowledge is an important part of local water management if one borrows Barth's theoretical framework. Having knowledge is vital to see what options are there to choose between.

Ralph Nicholas (1969) elaborates in his chapter "Rules, Resources and Political Activity" the connections between *values* and local level politics. He uses the term *resources* which is very similar to Barth's concept of *values*. Material resources can be money and land and human resources can be power over someone or even goodwill from someone (ibid).

A man will not continue indefinitely to give political support to or to comply with political decisions without receiving some return. The political leader must eventually provide something, for example patronage for his

supporters; the political official must satisfy his public that they are receiving, or will receive, something – law and order, justice, roads, or schools – in return for their compliance. (ibid:302)

Nicholas is here incorporating local level politics to the resource of value concept further than Barth does. Nicholas moves on to introduce the concept of *rules* in local level politics; He divide them into: (1) Moral principles, (2) Jural rules and (3) Technical facts (4) Pragmatic rules and (5) Regularities. (1), (2) and (4), he says, constitute the "actors model of his situation". (4) Pragmatic rules, however, is about how a politician can circumvent moral and jural aspects:

"If it is widely accepted in a society that "everyone buys votes," then vote-buying has become, for practical purposes, an acceptable and legal practice, although it remains an offence on the statute books. Each system has its rationalisations and justifications for apparently immoral and illegal political action." (ibid:305)

Rules and resources can thus affect and be affected by politics. The Barthian model above could just as well have added another feedback loop beside local water management. Later, in part three of this thesis I will focus on the important role of jural and moral aspects in local water management. As Nicholas mentions, jural aspects are very significant in human resources. In the field area this takes to a large extent the form of very old Islamic and customary law that today is under pressure, among other things, because of introduction of new technologies in water management.

The technical facts (3) (ibid) are the ideas or cultural constructions of what is locally regarded as possible or not in resource management and politics. This is, as mentioned above also a result of other actors' beliefs and actions.

Regularities (5) are causal connections that affect the actors, but that they do not know or reflect about (ibid). It can be seen as similar to the *aggregate consequence* of "environmental degradation" as mentioned above. The causal connection between increasing population and decreasing available water per capita can be another example. At the same time this concept also points to a level of knowledge the actors have about their own society or management system. The concept points to the difference between the factors the researcher can use in his model and the factors that the locals use in their "models". This is an important point because it highlights that the actor acts according to *his* information and not the researchers or other

observers. This is aptly illustrated in part 3.3 where it is presented that the locals do not perceive biological contamination of water as a direct cause of serious illness.

Local knowledge in local water management

Gunnar Håland (1993) takes the issue of knowledge in humans' interaction with nature to an elementary level: Talking about ecology in anthropology he states that humans are different from animals in the ecological realm in that they can gather knowledge about the environment and culturally codify and transfer this knowledge through language and symbols. He uses the term "cultural maps" for this knowledge. Without these and the language, humans would be totally helpless. These maps have to be somewhat reliable concerning the relationship to the material world, otherwise the human group could not survive.

In "Human Resources" (1967e:general conclusions), Barth writes:

"Conversely, the organisation represents an infrastructure that can accommodate and sustain certain forms of change and development: it provides opportunities as well as difficulties for development

Finally and more generally, the native society of the area has produced human resource of some qualities: a population with skill, interests and capacities which provide the material for development in the future."

Barth's use of the concept *human resources* has overlapping elements with local knowledge, as "skill, interest and capacities" certainly are important parts of the concept of local knowledge. Knowledge is an important part of the actors' framework, as information is vital in the construction of what is considered an option in the situation of making a choice. The knowledge may range from practical experience to knowledge about local social organisation and how to exploit cultural symbols in, for instance, local politics as mentioned above. In later years, Barth has also focused much on the social organisation and the process of transmitting knowledge. He argues that the social setting of the use and transmission of the knowledge is an important part of the knowledge itself (Barth 2002g). As I will present later in the thesis, local knowledge is a crucial factor in local water management. The actors calculate and plan their actions according to what they know. An example of this is the local knowledge of water hygiene.

Focusing further on the role of knowledge, Trevor Marchand (2001), wrote a chapter in "Negotiating local knowledge: power and identity in development" regarding the knowledge of minaret building in the Yemeni capital Sana'a. Marchand analyzes a special social situation of knowledge transfer: Apprenticeship. He shows how the situation of learning is characterized by power hierarchy, mysticism and hidden knowledge. Marchand also mentions how difficult it would be to transfer this knowledge to another social setting, for instance, if building conservation authorities wanted to collect the knowledge of minaret building with the intention to make organised classroom courses. The knowledge is so situated in its cultural and social setting that transferring the "bare knowledge" would cause it to change significantly.

"Agrawal (1995) tries to downplay the distinction between scientific and traditional knowledge, and finds that the attempts to introduce new technology from outside fail because they are just as anchored in a different sociopolitical-cultural context, as the local technology it tries to replace." (Andersen 2001:3)

The geographer Peter Andersen is in his article pointing to the connection between technology and local knowledge. Technologies cannot be separated from the knowledge of how to use them, and often this knowledge is far more than just how to operate a certain device in functional way.

I want to introduce Edwin Hutchins' book "Cognition in the wild" where he argues that knowledge also is incorporated into material structures we use in our daily life (Hutchins 1995). Thus *knowledge* is not only the cognitive corpus of information, but also tied up into social and material structures outside themselves the actors, surrounding them. The eco-technical possibilities and constraints in the model of local water management may be a good example of this. His empirical data is from the bridge of ship in the US navy and the research topic may seem first to be an ethnography of navigation. Hutchins uses the case of modern naval navigation to illustrate how much of the knowledge needed to navigate the ship is tied up in procedures, mathematic formulas and instruments, and on the bridge of the ship there is also a social organisation and internal culture. All these are actually needed for the actors on the bridge to use the localised knowledge of navigation.

Ståle Kundsen (2004) agrees about looking critically at the division between scientific and local knowledge. He argues that scientists, bureaucrats[7] and "locals" (in his study, fishermen) actually have much in common: Their knowledge is more "situated", as mentioned above, than most are willing to admit.

Science usually has claims toward being universally valid. "Proper" science should be able to withstand worldwide peer review. There are many examples of, that local knowledge does not take an active stand to the question of universal validity in either spacial or temporal distribution. This is perhaps one of the important factors that separate science and local knowledge, and this difference produces different bodies of knowledge with material, social and cultural implications. Local knowledge might be perceived as legitimate without having to be valid for people outside the "locality" and it does not even have to be defined or coherent. The topic of water hygiene in the field area is analyzed in this perspective.

The practical side of local knowledge certainly has much accumulated experience over time of testing and failing, and in this particular aspect, local knowledge and science can be seen as having a common methodology. Obviously, there are certain types of local knowledge, especially in cases where cause and effect are not very apparent, that draw their explanations from culturally accepted truths rather than scientifically established concepts. In part 3.4 of this thesis, I will point out some cases of water related local knowledge with the difference above in mind.

As mentioned above, Edward Hutchins (1995) focuses on the relationship between knowledge and the physical, material and practical world. However, he has an important epistemological and methodological point as well; just describing actions and the material world around the observer, would only give a small part of the picture of what is actually going on. It is necessary to have knowledge of basic navigation to understand what the different orders mean and for instance the importance of these, as consequences in certain conditions concerns the safety of the whole ship. Observation does need some degree of participation, or at least understanding, of what is practically going on.

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[7] He points to the fact that scientific experts and bureaucrats carry out much of the general resource management in our part of the world. However, the local knowledge used by scientific experts and bureaucrats is usually downplayed.

He discusses the span between the “real physical material” world and the cognitive images in our heads. In a practical topic such as water, this relationship is a very close one, just as in navigation. The intention behind the action is perhaps taken for granted, but still very much connected with the physical world. The cognitive images that knowledge can be said to consist of, are mere representations, but with a very indexical relationship. This means the symbols used are closely related to what they represent. Again using cycling as an example our image of the use and function of the pedals or breaks will always remain closely connected to their physical functions. That does not imply that they cannot have other symbolic or cultural meanings, but for researchers trying to document practical knowledge, the description would be very thin, if we had never tried a bicycle before and had no idea of how the user manages to keep it upright. In this case, a mere descriptive ethnography is not enough, unless we share the informant’s practical world. In part two and three in this thesis, I will give some examples of different types of local knowledge connected to the water management and how different these types of knowledge can be, in terms of being open and apparent for an outside researcher.

All this gives implications to our methodology; being aware of our level of functional understanding when describing practical knowledge is just as important as in understanding cultural context in a cultural system.

As I comprehend Hutchins, he is not afraid to reinterpret the informants’ ideas and knowledge when he describes and presents it academically. This is because the actual material basis for the knowledge is very much the same although presented through language and culture.

In a methodology course in Geography we were reminded that in cultural analysis we interpret the informants’ interpretation of the real world. In that way, there is a double interpretation (in fact triple, if one uses an interpreter). However, Hutchins’ perspective gives a more “positive” look towards the situation. When focusing on practical knowledge, we as researchers can have a very similar understanding of the “real world” as the informant has, hence our knowledge can be shared and discussed in common. A test of this view can be done in field conversations. If one manages to discuss over and over again without major misunderstandings there is a high degree of probability that you actually are able to understand the words and terms of what may constitute a common knowledge.

Related to development questions and more practical and applicable anthropology, the indigenous[8] or local knowledge perspective came in as a correction to development based on experts and outsiders to such an extent, that the sustainability in the development projects was threatened (Bicker 2004). The local knowledge perspective is thus also an ideological part of the wider development agency that is bottom-up focused and that focuses on the beneficiaries' abilities to manage their situation in the long term. This can empower the locals to give them tools to develop themselves. Far too often, the "solutions" from outside have made the locals just more dependent on others.

However theoretically, the concept of local knowledge is not yet well developed (ibid). The academic focus on local knowledge has very often been on the meeting between development and local community, and also about the problematic interference of development NGOs into local management. Therefore, it is a challenge to connect these problems and practically oriented perspectives and theories to a more academic theoretical debate. It is important, in my view, not to isolate "local knowledge" as something that appears only in the meeting between (development-) experts and locals. To be sufficiently critical towards this perspective, one has to connect it to other perspectives of knowledge and cognitive anthropology to test them and make them stronger and more universal.

Thus instead of focusing on local knowledge as something opposite to expert knowledge or science, I want to go back to Barth and the other theorists above, arguing that the important thing is to focus on the different *aspects of knowledge*. Fredrik Barth (2002g:3) states that knowledge has three faces:

(1)"A substantive corpus of assertions". The information or ideas themselves.
(2) "A range of media of representation". In what way is the knowledge communicated? With language, symbols or actions?
(3)"Instituted social relations". Under what social situations and relations is the knowledge used and transmitted?

[8] Bicker uses the term indigenous knowledge for local knowledge.

"This perspective secures the space for *agency* in our analysis: it makes us give the necessary close attention to the knowers and to the acts of the knowers – the people who hold, learn, produce, and apply knowledge in their various activities and lives." (ibid: 3)

Analysing the knowledge itself as corpus of information or as "cognitive maps", can be difficult in other aspects also; Bicker states that there is often a "Creolization of indigenous knowledge, there is often no consensus among the natives, and local stakeholder knowledge is not homogenous (Bicker 2004:2). Not only can local knowledge be incoherent and ambiguous, the locals may also disagree among themselves. This is a severe challenge when trying to academically "record" and analyse the knowledge. Whose knowledge counts more?

Another way of seeing knowledge as situated, can be done by looking to Barth's ethnicity theories. He focuses on what happens in the processes of the boundaries between ethnic groups, instead of, as was previously common, to only focus on the group itself and what symbols are used inside the group (Barth 1994a). I will argue that local knowledge can have aspects of boundary processes where the knowledge becomes meaningful because of ones position in relation to someone else. Disagreement about facts can thus create stronger "opinions" or knowledge legitimacy among parties in a conflict or along a social boundary. This may not be so easily seen in more practical matters but in situations of, for example, customary law, the severity and values at stake for certain actors will produce a more rigid and value laden type of knowledge. Obtaining certain types of knowledge can be a way for the locals to differentiate themselves against each other and outsiders. When having conversations about water issues in the field, very often informants would point out to me who was in position of having knowledge of what, and more importantly, what implications this had for having the "right" or "correct knowledge". Knowledge is certainly seen among the informants in of this study as having *values* or *resources.*

There is an obvious difference between practical knowledge such as how to maintain a collection canal, and that of value laden knowledge of legitimacy of social differences in a management regime. However both of them are present in local water management and there is no way of understanding local water management without taking into account this wide span of different aspects that local knowledge can consist of.

It is here, that social science can be applied in development, as the development sector, i.e. GOs, NGOs and the locals themselves, could benefit from understanding some of the complexities of trying to improve technology and (water) management.

”The philosophy behind the indigenous knowledge initiative is straight forward. It is based on the belief that effective assistance will benefit from some understanding of local knowledge and practices, by promoting culturally appropriate and sustainable interventions.” (Bicker 2004:introduction)

The quotation above is a “common belief” or myth in newer development approaches. By focusing more on the local political sides of development as well as applying sound social scientific models, it can hopefully be turned into something more than beliefs.

Different truths? Problematizing different types of data in interdisciplinary research

Newer trends in social science let the humans “into” the study, the informants, present what water management means in their view. This has been done in order to ensure that the analysis is not done outside the cultural horizon of the actors. However, the informants narratives are selected and interpreted in view of the scientists own narrative of what water management is, or should be, and also the scientific findings have to be presented in a scientific textual way. Interpretation of language and culture is inevitable as the scientist uses loops between data and theory in the research process. The final scientific presentation is often far away from most informants own presentation, even though it is a strong wish from the researcher’s side to present the information in a way that the informants can agree on the content or not. This is what Aase calls the “demand for adequacy” [9] (Aase 1997a:68).

It also should be taken into consideration the fact, that how one presents the world may be far from how your informants perceive it: Humans live in a political world and put *normative* content into their statements to change the world into what it *should* appear like. Human presentations may also differ much from “actual” observed action. And the informants themselves might not agree on what actually happened. A local person might thus do one thing, say another thing and think something differently.

[9] Adekvans-kravet

These theoretical questions are strongly connected to how to obtain data of good quality. Observations might be more "objective" than recording an informant's description of his own action. But the informant's own presentation might reveal other data that are less "objective", but perhaps more relevant: Why is he carrying out water management exactly like this? What is the value and meaning of this action? Mapping motives and meanings, one can easily "meet the wall" in social science as it approaches psychology of the individual, but staying on an aggregate level, individuals' and groups' intentions can, to a large degree, explain the underlying cause of the observable action. Description and analysis of a management regime may thus render data with different epistemological origin:

Three types of data according to:

1 Observations of water structures and water related action,
2 Informants own presentation of water management
3 Identifying systems or causal models on an abstracted theoretical level, such as for example in local economy or interpreting cultural symbols and categories.

These represent very different types of scientific representation of reality, with different claims of objectivity, and also very different degrees of usefulness and applicability.

Pedynowski (2003) argues that there is no single "science" with only one degree of "truthfulness". On the contrary, she argues that the different sciences ranging from Physics and Chemistry via Geography to Language and Culture studies, all produce different kinds of data and theories that claim different types of truths. This implies that in an inter-disciplinary theoretical perspective like local of water management, where the scientist takes advantage of "different sciences", he also faces the dilemma that the different types of data he tries to merge into a synthesis each have different epistemological claims.

In my case, the field context was very different from my own culture. Combined with a qualitative approach, this makes the overall data very differentiated in respect to epistemology, "objectivity", and usefulness outside social science. I have therefore tried to point out, as the presentation goes on, of what type the data is and how it is obtained.

1.3 Research methods

The main method in the thesis is qualitative method. The field area is geographically wider than what is normally called a *case study*, however one can say that the local water management and the rainwater harvesting cisterns have been case studies. Further, certain aspects of the rainwater harvesting cisterns have been investigated more thoroughly than others. An example of such a case within the case is chapter 2.5, the description of the traditional plaster that was used to keep the cisterns watertight.

Most of the data come from the fieldwork. Observation, open ended interviews and field conversations have been the most used methods. They are often very interrelated as one piece of information rendered by one of them can successfully be used and followed up in the others. In addition to this, different types of literature have also been very valuable, especially as a means of providing a context to the field before going there.

Finding a field

In the beginning of the project *Yemen* and *water* were the only focus. Numerous emails to different GOs, NGOs, companies and individuals were sent. I received a reply from ICS-Hajja / Vision Hope International, a small NGO in Hajja City that undertook local community water projects, hereunder restoration of traditional cisterns. They welcomed me to stay there and they offered to help me with practical matters. They had previous positive experience with a student doing fieldwork there before. The NGO also had a good locally driven implementation side of the organisation and this provided me with the ability to travel out of the city to the countryside to many different villages. The fieldwork lasted for six months, divided in two periods, however the actual time in the villages around Hajja was considerably less, since most of the time had to be spent on practical matters.

Qualitative method

The whole research process has been of an exploritative nature, both concerning the actual topic of research but also of how to gain knowledge as the field area is very remote from my own background geographically and culturally and in many other respects. The broad qualitative approach has been chosen since the topics of the rainwater harvesting cisterns and local water management, especially focusing on domestic water, have not been previously described in depth. The advantages of being open to new topics and connections between them could not have been possible, if the research was done with purely quantitative methods. That would imply severe probability of missing central new points. The topic of the water trucks, as mentioned later, is a very good example of this, as they would not have been taken as "data" if I did not have a research method that could be open for new categories and continuous reinterpretation of the collective findings. The learning process is very much present throughout the fieldwork, at the same time as one gets more and more new questions. Qualitative method is much more than quantitative methods, characterized by a cyclic loop between research question(s) – data collection – theory – analysis. In quantitative method this is performed more linear and planned manner (Wadel 1991).

Generalizability in qualitative methods:

The strength of qualitative method is the ability to quickly go into depth and explore what is there to be found of different phenomena, and further, of their interrelated causal connections. The main problem is that one cannot generalize ones findings to be relevant outside the particular case. This is arguably, more differentiated: Several case studies can be made comparable if the researchers use similar theoretical perspectives and other measures are taken to enhance comparability. A qualitative study can also draw upon advantages from quantitative methods by making sure that ones findings have some kind of statistical probability for example by looking at the same phenomena in not only one village. In my case, many different villages were visited over a wide area and thus it can be said that the study is not purely qualitative, but rather focuses on the one phenomenon throughout a certain area. One might even think of qualitative method as a cluster of different case studies that together are able to explain complex issues. The cases do, of course, not have to be geographically limited, but rather related to topics.

After the initial phase where one has to get an overview, it is necessary to focus on certain key topics. That does not mean that new ones cannot be raised, but rather the delimitation of scope allows more resources to be spent on following certain phenomena further into depth. When one feels that one has enough knowledge about a topic to include it in the presentation, a last step can also be made: The same phenomenon can be raised again but in a more quantitative direction. For instance the same question can be asked over and over again in field conversations or semi structured interviews with different informants to make sure there is a certain statistical probability for that ones finding is valid for a wider area. This is especially important if one tries to describe a group of related phenomena such as rainwater harvesting cisterns over a wide area, rather than focusing of the use of cisterns in one particular village. If data is gathered in one village only, the data is not automatically generalizable to the whole district.

The process of choosing a field site is very important, as part of the goal of this thesis is to come up with data that are comparable with other small scale water systems elsewhere.
Janet Schofield (1990) argues that a case or a field should be chosen carefully: Ideally a *typical* field should be chosen over practicality. Different field locations can be chosen and compared. This will make the typical more visible, but also depends on what approach will be most profitable. A field that is ahead in general development will stay relevant and comparable for a longer time. It is also important to make sure that what is observed is not just a special stage in a changing yearly cycle, but focusing as much as possible on the whole cycle, for instance, the water situation throughout the entire year.

Köbben (1970) states that without other similar cases to compare with, one would miss many central questions, thus comparison is itself a necessity:

"Without knowledge of other societies I do not even know where to look or what to look for. The Bush Negroes, though a matrilineal society, have not the matrilineal conflict: without knowing of other matrilineal societies I could not possibly have noticed this for the curious fact it is." (ibid: 414)

Here, he points to the fact that the study itself contains background information that the researcher brings with him into the field, both in form of general perspectives and theory, but also details about similar systems elsewhere. A qualitative study is never the "deep well" it is sometimes claimed to be. Both before and after the fieldwork one does draw knowledge from

other cases into the wider research process. Thus, he argues that one should compare and hence widen one's research and at the same time go deep, and try to gain benefit from both simultaneously.

Before travelling to the field area I planned to spend the first half getting to know the whole area and collect general information and then, during the second half to focus on one or two specific villages. Practical and circumstantial conditions made me drop the plans to focus more narrowly. This was mainly because of the knowledge I gained about my own status and how difficult it was for locals to give me personal information about ownership, political and economic status. Staying under very basic conditions would also reduce the overall efficiency in data collection. As I changed direction to focus more on what could be generally said about local water management in the field area, I tried to close the gaps of uncertainty that existed, instead of looking for new subtopics or going deeper into the ones I already had.

Practical challenges

In reality, practical matters do take a strong lead: I had to arrange a visa, residence permit, travel permit and research permit. It had to be clear that I did not work for the NGO because of the difficulty of obtaining a work permit and the consequences it would have for the NGO if it was perceived that I did so. The road to Hajja had severe travel restrictions, especially practically speaking when one falls between the only two traveller categories; the "tourist" and the "development expert". After the kidnappings in Marib and Shabwa in Autumn-05, travel was made even more difficult, especially leaving the first checkpoint outside Sana'a. Two of the roads branching off from Hajja City also had police and military checkpoints along the route and made travel, without locally known companions, somewhat challenging. If there was one situation when it was very different being a foreigner it was during travelling. For instance, if I would have done more work on following the water trucks, this would have been very difficult. Most of the springs where they fill water are past one such checkpoint and locals often expressed very clearly all the additional problems it created for them to be carrying a foreigner. It meant obligation and involvement with branches of the police etc. that they themselves were not used to dealing with.

The fieldwork was divided into two periods and in the second one I had gotten a good, formal research permit that helped, but being officially a student still raised much concern about where I belonged, and in my interpretation, concern about who was my patron and what I was *actually* doing there. Development experts and tourists would always be attached to a company, which I was officially not. The checkpoints also represented a psychological obstacle to me (as one of my more intellectual informants formulated it), especially in the beginning when not knowing how to act and what to say.

First I stayed with "other foreigners" from the NGO that invited me, however, during the second field period in particular, I tried to loosen these bonds. I rented a flat together with other local students from the area. The city of Hajja was used as a base and several trips were made to different areas. It was the plan to stay in one or two of the areas that seemed representative for the data collections' sake for a longer time during the second field period. This was not carried out due to the combining factors of several practical problems and I thus stayed most of the time in Hajja city.

The global world in Hajja: The "cartoon-episode" of February 2006

The "cartoon episode" caused a large setback in the overall process of feeling at ease and thus focusing on the fieldwork. Indeed feeling generally at ease together with understanding local language, customs and culture was just as challenging as the logistic side and took a very large portion of the resources during fieldwork. Just overnight, the relative advantage of being Norwegian compared to for instance American was turned around. It was scary that something from a place so far away could stir up so many hard feelings in such a short time. It was also personally hard on top of other integration challenges. The incident above made it crystal clear that that Yemen in 2006 is part of the global world.

Interacting with locals as a source of understanding the "world view"

Getting friends and acquaintances in the city introduced me to elementary cultural skills. This was very useful when doing day trips or trips for 2-3 days to the villages. The villages around Hajja city are the main field area, but still most of the cultural data was obtained in the city.

Often acquaintances in the city were the start and the opportunity of a trip to their relatives or home in the villages. The soft start by staying with the few other foreigners in the beginning can not be underestimated and a period of cultural acclimatization was necessary. Having a local interpreter/research assistant the first period was fundamental to get to know the basics.

My affiliation to the NGO was a central issue in people's perception of my status: Aase illustrates in his chapter "En status som passer for meg?"(Aase 1997a), how informants' perceptions of the researcher's status, i.e. role, affect the flow of information. He states how a status has attached to it certain expectations of behaviour. These expectations also govern what is considered "proper" information that the researcher may get a glance into. Simply speaking, for me as a male, it was expected not to ask personal questions regarding female relatives of other men. However, my status as an "outsider" and "foreign" was open to negotiation. Aase's main point is that if the ascribed status one gets as a researcher gives little information, it is possible to act opposite or different of what is the expected and thus "break" with the informants' expectations. This will "force" them into finding a new status for you that can allow you to get other and new types of information. This can be illustrated with one of my friends that liked to joke with anyone that had never seen me before, and he could find amusement in claiming that I was indeed a Yemeni to others. The other person would become a little bit uncertain for a while. "He speaks Arabic and he wears the Palestinian shawl, yes why not?" My lack of fluency in Arabic always revealed my "foreignness" after short time. However, using clothes to symbolize who you *want* to be seen as, does have an effect. Knowing "local symbols" such as slang, names of places and poetry also "proves who you are" and to which category you want to belong. To show that you break with some categories and internalize others, one is to some degree, able to compose ones own mix of categories in order to establish one's own special status. Nevertheless, this is a long and continuous process that will be perceived differently by different persons and groups (Aase 1997a). Here are some of the statuses that I found relevant:

Different categories of foreigneres (éajnib) in Hajja:

khabír (pl. khubará)	Development expert
sáih (pl. suwwáh)	Tourist
duktúr fí al-mustashfá	Doctor in the Saudi paid hospital. (some Russians and Asians)
tálib (pl. tulláb)	Student

The “student” status was the one I could “use” with most success, especially if I claimed to be interested in Yemeni traditional culture and history. Contemporary studies of local water management were not accepted as easily.

Use of interpreter, research assistant

During the first field period, I was much dependent on a translator. He was working in the mentioned NGO and had studied some English. He quickly became more than a translator. I think the word interpreter is better as the translated statement was certainly also at the same time interpreted. Before entering the field, my supervisor advised me to take advantage of all the positive sides of using an interpreter and this was done with a great success much of the time. The most important aspect was to get a second hand view of the same observation. Thus the contrast between my impression and my interpreter’s could be a starting point for a new “thread” in the qualitative approach. If he brought a friend or a driver from his circle of friends, I would have two such research assistants that could give a cultural interpretation. Their interpretation was still outside the informants’ subculture in the countryside, but importantly, much closer than I could have achieved myself.

Group conversations

The use of interpreter had some limitations, but was most successful during short semi-structured interviews such as a short visit to one of the daily qat chewing sessions that typically lasted 3 hours[10]. During the initial phase I was invited, by the help of the network from the NGO to different villages in the field area and thus used these visits to formal qat-chews as a setting for semi-structured interviews to get background information about the village and its area and its specialities compared to other villages and areas. The afternoon qat chews are mentioned by all western social scientists using qualitative methods as being a fantastic setting for semi-structured group interviews. However, in the more formal qat-chews, only those of high rank would express their views and the rest would be rather quiet.

[10] As a distant guest one may arrive a bit late and should certainly leave well before the evening prayer (ôishâé), thus the formal qat chews are not as long as informal ones.

During smaller, more informal qat-chews far more discourse, discussion, negotiation and even conflict could be observed. Most of the regular afternoon qat-chews represent an important "focused social event".

After several such visits to different villages I could make myself a picture of what was common and normal and what was special both to that village, related to eco-technical, socio-economic and cultural issues. The informal interview guide quickly grew very long and I had to try to focus on economy of information. That meant looking at what was the special aspect of the specific field situation and try to identify on what topic the specific informants could contribute most.

My perceived status; positioning oneself

The group interviews had various challenges attached to them. In the beginning I was not aware of the fact that I was perceived solely as a development expert employed in the NGO. Often I was shown potential building places for cisterns in hope that I would donate money or cement to build a cistern in that place. Or it could happen in the low lying areas that I was taken to a well and asked if it would be an economically sound investment to dig it deeper as it yielded very little water at the present time. When I understood which status was ascribed to me, I tried as much as possible, as suggested by Aase (1997a), to break with it. I tried to explain that I was interested in traditions and history of the cisterns as this topic was the only one that people could associate with something a student could study. An Anthropological or even "water-geographical" study was not understood. Actually the whole issue of chewing qat (takhzin) was one of identity. The other foreigners in the NGO did not chew qat. During the second period, I stopped this cultural habit since the NGO was getting some difficulties because of this. The issue of chewing qat was often perceived as a symbol to whom and where you wanted to belong. As Yemenis are among the few Muslim peoples who publicly legitimise the consumption of this mild narcotic stimulant, chewing qat is understood as a very "Yemeni" thing. Qat enabled me, partially, to demonstrate that I wanted to learn more regarding their way of life and further show respect to Yemeni custom and culture.

"What is the most difficult language, ôarabi éaw éajnabi?" (Arabic or foreign)?

This question, in addition to the context, revealed to me that the man asking was using the two categories; "Arabic" and "foreign", as the most basic typology to distinguish between his identity and presumably mine[11]. There were also other categories applied to me. The point here is that the available typology of categories of foreigners in Hajja depended on what level the individual and the subculture had been exposed to impulses from outside. The variety of stereotypes applied to me was confusing in the beginning.

As I was often perceived as working for the mentioned NGO, I sometimes during short visits had to accept that I could not change the status that was ascribed to me there and then, and I just had to learn how to use it in a best possible manner. My informants wanted support for cistern restoration from me and I wanted information about the local water management form them. It was often a strange form of "value exchange" where I simply did not have any cement to offer, and that made me often feel quite bad.

Reflexivity is an important tool in "empathy on an aggregate level". I tried for instance to imagine if someone very "foreign" came spending time and effort in my street studying something very obvious such as, for example, the postal system. Or what some of my rural relatives would do, if someone came to investigate the local driving style. It might sound irrelevant, but actually the whole fieldwork process was enhanced by trying to comprehend what others were thinking about me in order to know how the flow of information was manipulated. At the same time, a high degree of honesty is needed. You cannot be a "friend" without true feelings and this is one of the most significant dilemmas; how to be genuinely interested and at the same time collect the information and move on.

Breaking the ice

When going to villages attending group conversations and conversations alone with farmers in the field, it was necessary to have certain topics to "break the ice" and keeping conversations going. Using the local language and communicating directly, was always met with great enthusiasm. It literally opened many doors. I tried to specialize on topics such as

[11] Usually a far more sophisticated typology is used. In general after not being Arab and Muslim, the next division is "German" and "American", as the Germans heavily engage in development activities in Yemen.

local place names, cistern and agricultural details. For instance knowing by heart some pre-Islamic and classical poetry made me advance much in popularity according to the "intellectual" informants such as village teachers. The various informants showed very different degrees of interest in discussing or showing me around and I quickly tried to use the situation whenever a "key informant" showed up. However, probably due to the broad geographical scope, I did not have key informants to follow for a longer period of time, except friends in the city who had never lived in the countryside.

"Recording" data

Using a camera, tape recorder and note-taking in front of the informants was a mixed experience. For the use of camera see appendix 4.4. Sometimes the flow of the conversation was broken if I reached for the notebook. To a large extent, I did not take notes in front of the informants, but waited until the evening. It felt uncomfortable to make the atmosphere of the field conversations "formal". However it did happen that some informants said, "Why don't you write anything, you are a researcher right?" But, this was only with informants that knew what my goal was. In topics of recording history of folk culture, note taking was perceived positively. The same was the case if I wanted to write down a new word before I forgot it. Conversations about "problems" that could imply that someone else had done something wrong, were times where note taking was not perceived as appropriate. If criticism was ever stated it should certainly not be written down.

Informants outside the field area

In the capital Sana'a, I got much help and guidance from western development experts, Yemeni academic scholars and even from friends that had grown up in the countryside and could give me valuable information about life in the countryside and data for cultural analysis. Numerous conversations with talkative taxi drivers, when stuck in traffic, were a very good way to get an impression of local conditions elsewhere in Yemen because most of the inhabitants of Sana'a moved to the city as adults from all over Yemen. As the water and agricultural situation is similar in most of the western part of Yemen, conversations with taxi drivers provided a sort of extended field. When being in Sana'a, staff in libraries and

bookshops also proved extremely helpful. The qadad-maker-group (as mentioned in part two) was a field situation outside the main field area that proved that local knowledge does not have to be local in terms of geography. Thus, visits to Sana'a also made easer for me to see the field area from outside and to withdraw from what was studied, so that the distance allowed more objectivity. Certainly much time was also needed to create a private atmosphere to digest all the images and ideas experienced in the field area.

Literature review

Literature concerning water and society in Yemen is very fragmented (Varisco 1997b:251) and takes a great deal of effort in terms of searching for relevant sources, however a great deal of documentation is available. There is a lack of proficiency in English among Yemeni scholars and the weak state of copyright issues compels many scholars to keep their publications at home. In general, "inapplicable social sciences" have a very low position and research and theory building for the sake of knowledge has a very low position in the public debate today according to the anthropologist Steven Canton (personal communication). Cultural relativism as an analytic tool is not at all compatible with values in the wider society and thus suffers even inside Yemeni academia. In general the written sources can be divided as follows:

1. Western academic sources
2. Sources from western development agents
3. Yemeni governmental organisations
4. Yemeni academic sources
5. Historical works such as al-Hamdani's "Sifat Jazirat al-ôArab" also partially translated and indexed by westerners. Western travel literature does also provide some detailed historical records.

When Yemen opened up to the outside world in the 70's, a wave of western academic researchers ended up writing PhD thesises from their experiences. This literature has been an invaluable contribution both before, during and after fieldwork.

Tools in the field: The water landscape approach.

Entering the field gives a shock of initial information. It is strictly necessary to delimit the information flow especially during the initial phase of the fieldwork. It is necessary to develop "tools" to filter out everything but the most relevant information in order to be able to process and analyze it.

Standing on top of a hill looking over an area of several cisterns of varying sizes and state of filling, different springs and canals, hoses and pipes going all directions made me ask myself the question: What on earth is going on with the water in this area? I was there to understand how the water was managed, but I quickly understood that I first had to find out where the water came into the picture in the first place, and which routes it takes through the natural and man-made cultural landscape. Only then, could I start to vaguely see that the landscape was full of water structures. More about this "tool" is elaborated further in appendix 4.3.

Part 2

Description of the field area and eco-technical possibilities and constraints

2.1 Geographical description and analysis of the field area

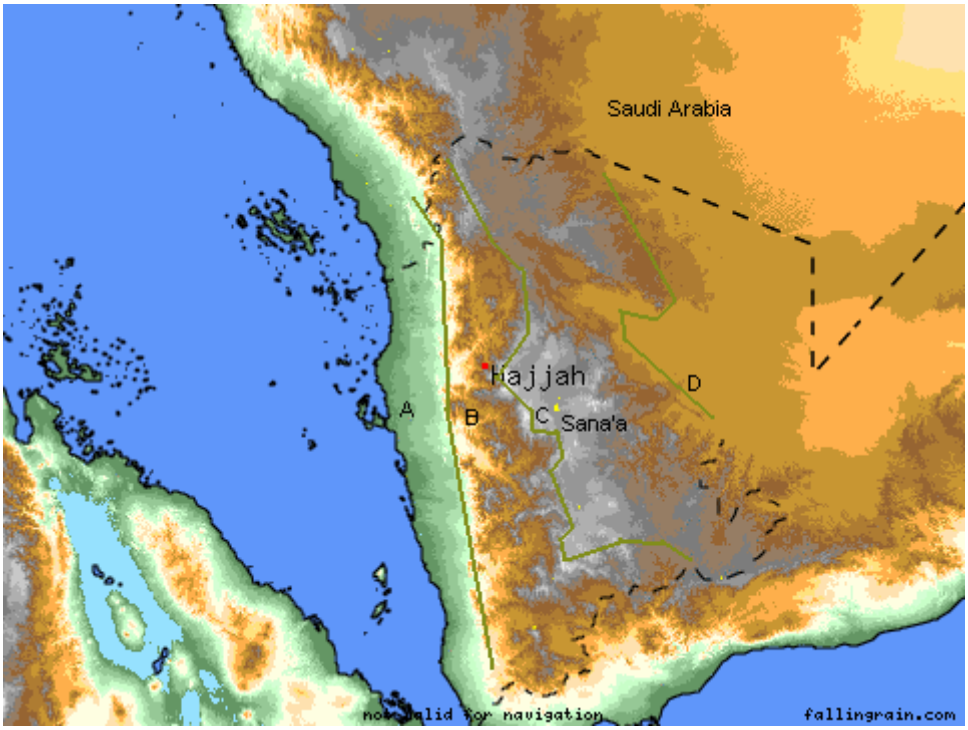

Fig. 2 Map over the western part of Yemen. The green lines indicate the borders between different geographical zones. (Fallingrain.com)

The location of the field area

Yemen is located on the south-west corner of the Arabian Peninsula and the map in fig 2 above shows the topographical features of the western part of the country. The grey colour on the map indicates areas above circa 1500 masl, and the obvious striking feature is the chain of mountains extending along the western area of Saudi Arabia southwards into Yemen. This mountain chain has its highest peak in Yemen just west of Sana'a, namely Jabal Nabi Shuôayb at 3760 masl. There are large areas above 2000 masl. It is common to divide this part of Yemen into four distinct geographical zones A, B, C and D of which B covers the study area and has thus been given most attention in the following description:

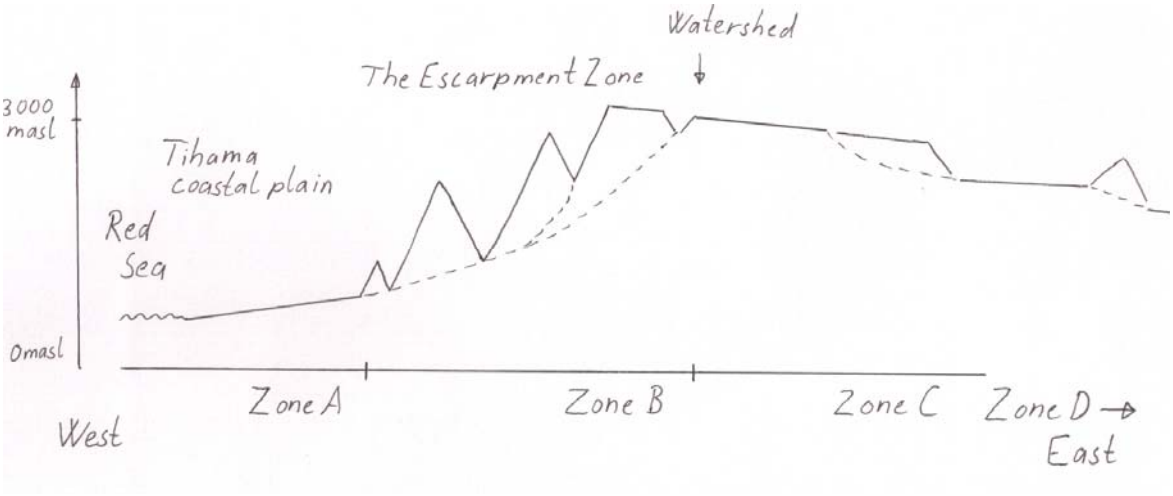

Fig. 3 The figure shows an east-west cross section through the western Yemeni mountain range at the latitude of the field area. Most of the rain falls in the Escarpment Zone and because of this the area has the largest population density in Yemen if excluding cities.

Zone A: The western coastal plain of Tihama: The climate is extremely warm in the summer and quite humid along the coast. The major wadis[12] run from the mountains and onto the Tihama. Where this happens the water, which mainly flows in the rainy season, is used in large traditional flood (sayl) irrigation schemes (Maktari 1971; Varisco 1983b). Today, these irrigation schemes additionally recharge the aquifers on the coastal plain and make possible quite a large extraction of groundwater through well pumping. The main water courses (wadis) hardly ever reach the sea except during an extraordinary wet rainy season. The population is centred around these schemes and in cities, and is distinctively different from

[12] A wadi is a either a valley or watercourse in the valley, dry or wet.

the highland in terms of culture, organisation and traditional mode of production. This area has been conquered and under foreign influence much more than the mountain areas. The region is quite flat and slopes increasingly upward to an area of foothills representing the start of the Western Escarpment Zone.

Zone B: The Western Escarpment Zone: Most of the field area is located in the Western Escarpment Zone. Geographically the zone is dominated by the high topographical relief created by the uplifting of the edges around the Red Sea part of the "Rift Valley Complex". The natural erosion rate is still quite high, but since most of the mountainsides are terraced, and most running water is led onto fields, the erosion occurs during incidences of severe rainfall. Since the watercourses usually do not reach the sea, the present day erosion leads to sedimentation in the middle reaches of this region and this is locally a phenomenon that seems to increase. The western limit of this area is Tihama foothills, and although not exact, can be drawn at circa 500 masl. The eastern limit is defined by the water shed border between the east and west flowing water. Water flowing eastward into the desert would in very wet climatic periods have to flow all the way into the greater Wadi Hadramawt, and this long distance makes the erosion force on this side of the watershed border almost non-existent compared to the erosion rate in the Western Escarpment Zone. The major wadis have a gentle slope in the lower reaches, but as they subsequently branch off, they become steeper as one moves upstream. The watershed follows a height of circa 2000-3000 masl.

This zone is the part of Yemen that receives most rain. In the south, it is not uncommon with 1000 mm of rain annually and in the north around Hajja this seems to be around 500-700 mm annually. Good primary sources about rainfall statistics are very hard to find. Rain falls in two rainy seasons around March-April and August, but varies much in onset, amount, local intensity and duration. The rain often falls during heavy tropical thunderstorms. In the field area frost is not present, however, at around 2500 and upwards it does occur and limits the main cash crop agriculture; qat and coffee.

Zone C: The central plateaus and eastern mountains: Here the relief is smaller and several large plateaus and alluvium filled basins exist in between more mountainous areas. Rain becomes scarcer towards the east and the heat increases as one descends.

Zone D: The desert zone has a less defined limit, but can be said to be where permanent agriculture is impossible. In some of the areas there is a minor escarpment that marks the border between the mountains and the sand-desert that extends into the Empty Quarter.

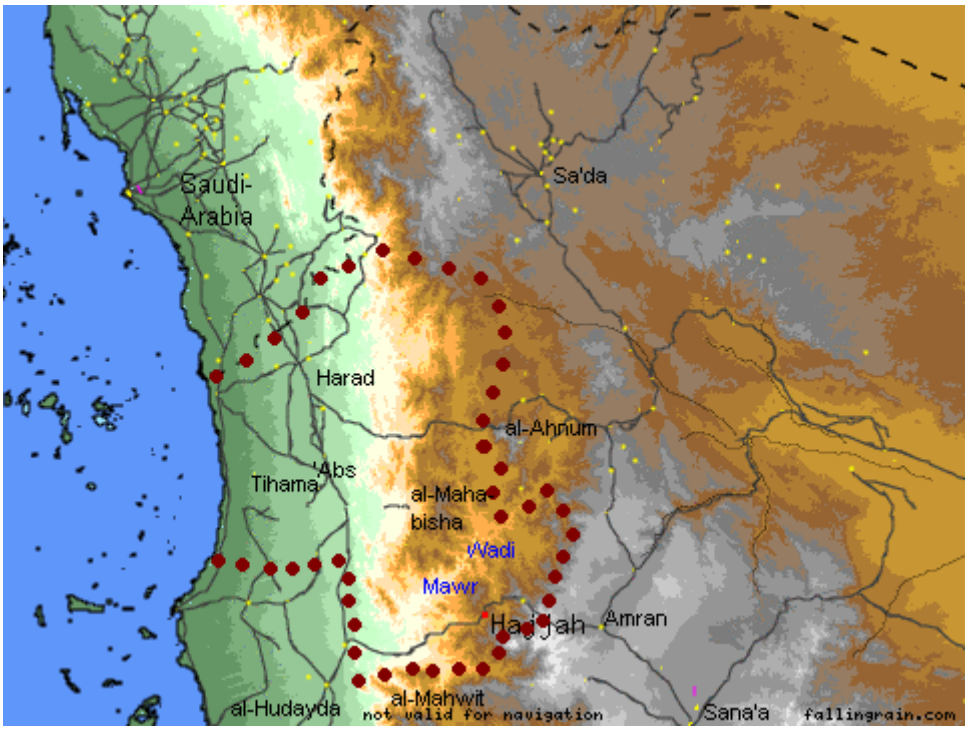

Fig. 4 The Governorate of Hajja with the approximate administrative borders marked by red dots. It borders Saudi Arabia across the coastal plane.(Fallingrain.com)

The Governorate of Hajja falls into the categories of zone A and B on map 1. One major exception to the general picture of the Western Escarpment Zone is the Wadi Mawr, which is the largest western flowing wadi in northern Yemen according to catchment area with its 9262 km2 and length of about 300 km. It has a base flow of water of circa 2 m3 per second in the dry season, but reaches about 15m3 per second as an average in August (al-Hafyān 2004:153) The wadi widens out and forms a large inland depression with the mountains of al-Aḥnūm in the middle, and the mountains of al-Maḥābisha[13] on its western side. (See fig. 4)

Yemen in divided into 20 governorates and Hajja is one of them. The Hajja governorate (muḥāfaẓha) borders Saudi Arabia and the governorate of Saʿāda to the north and ʿAmrān to the east. To the south is the governorate of al-Maḥwīt and to the south-west is the governorate

[13] The mountains of al-Maḥābisha contain several administrative districts of which al-Maḥābisha is only one.

al-Hudayda. The administrative centre, Hajja City, is located along the tarmac road that was finished in 1982 connecting the governorate directly with the capital Sana'a through the city of ôAmrān. The population density is clearly higher in the mountains and in cities around the irrigation schemes on the coastal plain (al-Jihāz al-Markazī li-l-Ihsā' Wizārat al-Takhtīt wa al-Taôāwun al-Dawlī 2000:37). The lower inland areas are scarcely populated as are the areas closest to the coast. These areas are frequented by semi-nomads that herd livestock and keep bees. Special tribes keep camels for the gathering of firewood, but these are usually owned by highlanders.

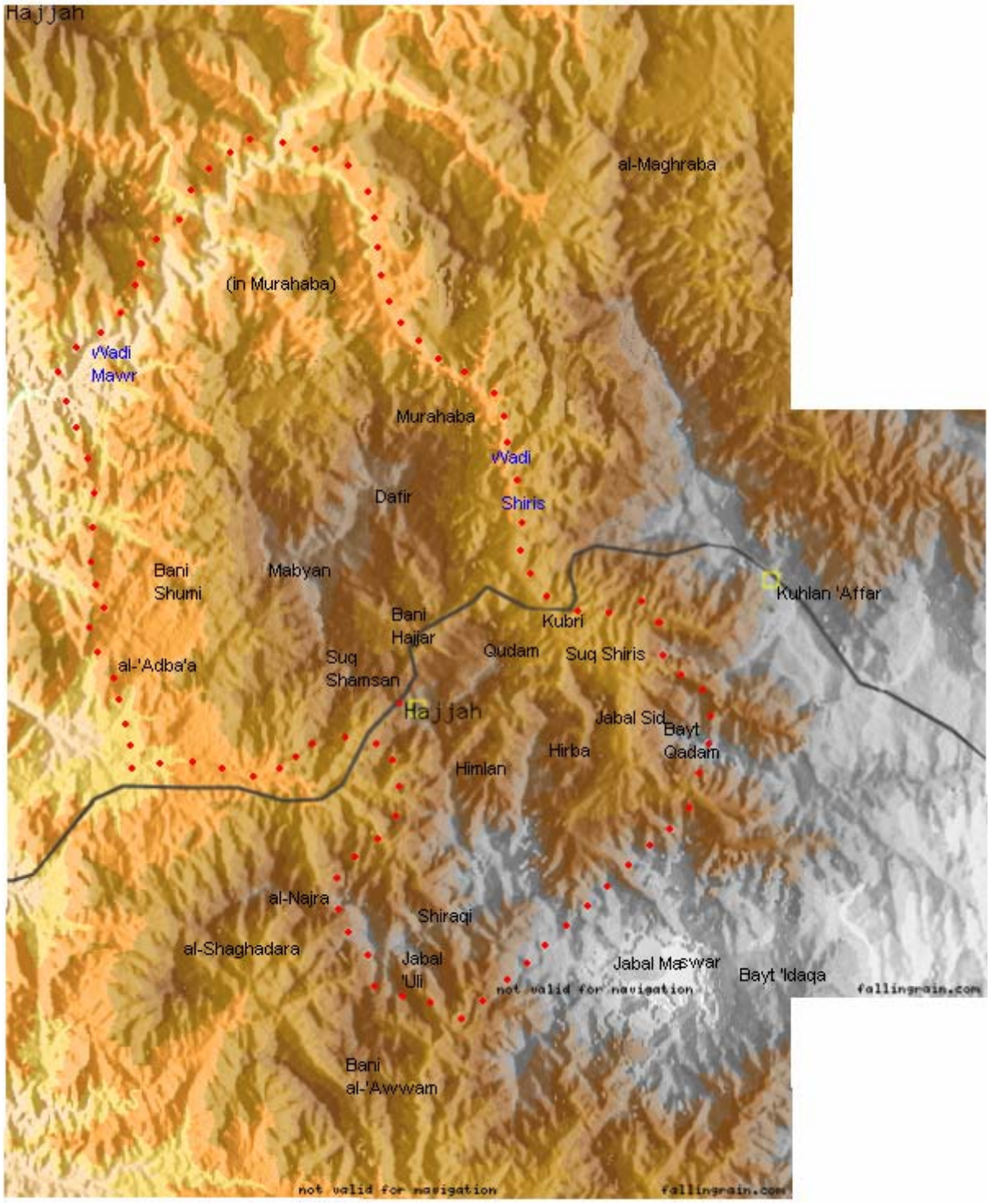

Fig. 5 (Fallingrain.com)The geographical extension of the field area. The grey line is the main road from Tihama to Sana'a passing through Hajja City. The lowest point where Wadi Mawr exits from the map is about 500 masl and the highest at Jabal Maswar about 3200 masl. The city of Hajja is located at about 1600 masl. The water for the public waterworks in Hajja city is taken from a well field one kilometre upstream of Kubri where the tarmac road crosses Wadi Shiris. From there the road ascends 1800 metres to the top at the right edge of the map before it descends onto the highland plain of Qâ' al-Bawn and the city of ôAmrân.

The field area is located in the clusters of mountains seen around Hajja City in the south-eastern corner of Hajja Governorate on the map in fig. 4. The field area is shown by red dots

on fig. 5 and visited places within the field area were travelled to. The reason for this delimitation is that the NGO I cooperated with had a contact network in this area.
This area also coincides quite well with the administrative borders of the *districts* (mudīriyya, -āt) of:

1. Mabyan (most of the area north of the road)
2. Hajja City
3. Hajja[14]
4. Shiris[15]

The total population of the area is 147120 according to the survey undertaken in 2004 (Maktab lil-ʾihsāʾ al-Jumhūriyya al-Yamaniyya muhāfadhat Hajja 2005). The overall population density of the field area is 497.8 persons / km2. This figure includes the rather dense core of the city itself, but also includes vast areas with almost no inhabitants such as the low laying northern areas of Mabyan and also some of the steepest areas in Shiris where most of the population is along the wadi itself and the populous mountains of Bayt Qadam. In Shirāqī, that is, the common name for the four sub-districts (uzla, uzal) in the mountains south of the city[16], the landscape is also very steep, but traditionally, the area is rich in agriculture due to its high altitude and abundant rainfall. The population density for these districts alone is 385.5 pers. / km2. The effects of labour migration is uncertain when it comes to who is registered where, but no doubt do some of the areas, densely settled in old times, reach this figure. The presence of the city and the rather new road system makes day-work or short time work commuting possible for large areas of the field area. The high population density puts extreme pressure on local water availability. If there is an average rainfall of 500 mm annually, it means 500000 m3 of water / km2. In the district of Hajja this implies per individual per day 3.6 m3 of purely potential runoff per person per day on a non permeable surface. It is obvious that this is little taken into account the water that is used in agriculture, lost to evapotranspiration and surface and sub surface outflow from the area. The fact that rainfall is highly variable in intensity and temporal distribution is the reason for the need of

[14] The areas to the south of Hajja city includes four sub-districts in Shiraqi and one down to the west of the city.

[15] This is a long narrow strip down in Wadi Shiris consisting of Upper and Lower Shiris and the only "mountain" included is Bayt Qadam.

[16] Except Hirba and Himlān that belong to the district of Hajja City.

storage tanks, or cisterns, in rainwater harvesting systems. The storage of harvested water in the soil of the agricultural terraces of the area is undoubtedly the most important human made storage capacity of water in the field area. The detailed effect of the terraces on recharge of the highly important local aquifers and springs is completely unknown to science.

Several areas are covered by public waterworks. However, the detailed coverage, the amount of water served, and the actual service provided for the inhabitants in terms of regular water supply for a fixed price, is so diverse and so chaotic, that I simply could not follow this up in this study. Coverage varies according to season and water availability at the well fields. Who get water in the tap is a semi-political question to ask. It is stated everywhere that water from the public waterworks for qat irrigation, which is officially illegal, is done by those who can afford it, as this water is the cheapest water available. An exception this is existing cisterns that are already built and the investment already paid or a share in a spring. Prices from the public waterworks vary, but the main one in the city costs somewhat less than 1 USD/m3. The water is expensive to provide as it has to be pumped from wells in the wadis up to where the main part of the population lives. The main waterworks of Hajja City has its well field a kilometre upstream of the bridge at Kubri in Wadi Shiris and the water is pumped almost 800 metres up by three series connected pumps.

The water consumption where public waterworks exist varies much according to economic capacity so again, these issues have not been followed further here. The actual usage of the public waterworks thus varies according to season of the year, frequent rationing in certain geographical areas, and economic power of the individuals, both when it comes to usage, and whether or not one can afford to get a pipe connection, legal or illegal. The electricity coverage is steadily increasing during the latest years. Taking all the above factors into consideration, I would say as a rough estimate, that one third of the population enjoys a somewhat regular piped water supply excluding the city core. Among this third, rainwater harvesting in traditional cisterns is not done for domestic use. For the rest, having alternative sources, such as rainwater harvesting cisterns, is necessary and in these areas the cisterns are being used and old ones sometimes restored. Individuals with money would anywhere in the field area build large private cisterns or restore old large ones for the purpose of irrigation. If the local circumstances are favourable this is done even in areas of coverage from public waterworks as harvesting of water for irrigation, or sale on the truck water market can be seen as “harvesting money”. Thus the question of physical coverage from public waterworks is not

directly relevant to which extent rainwater harvesting is performed. The effects of coverage of the public waterworks on the use of rainwater harvesting seem gradual, complex and not very clear.

Although the field area has been given above, I would like to point out that neighbouring districts, such as Bani al-ôAwwâm, al-Shaghâdara, Najra, al-Maghraba, Kuhlân ôAffâr and Bayt ôIdhâqa[17], have very similar eco-technical, social and cultural characteristics as far as I know. Although not visited, I have had conversations with many people from these areas and the description given of the field area could well suit these surrounding districts in a general sense.

The wider geographical description above is also based on the topographical map series 1543 B1, B3 and B4 with a scale of 1:50,000 (Survey Authority 1989)

Presence of fog

Fog occurs mainly during the dry winter season, though it may also take place other times of the year. This occurs mainly in the higher altitudes and especially on westward facing mountainsides. The fog reduces the plants need for water as the relative humidity of the air is higher here and thus also the overall evapotranspiration. Eastern facing mountainsides in the same altitude seem to have a distinctly reduced presence of fog. Fog is not only fog; the "wetness" of the fog varies much. At times, the fog or low clouds, start condensing on any object that it passes by, for example a mosquito screen, and produce water. In this type of fog, small drops have already formed and when they hit an object they aggregate into water. It is not found that the fog is used consciously in the field area as a direct water source.

[17] The district of Bayt ôIdhâqa which covers the mountain of Jabal Maswar (circa 3200masl) is part of ôAmrân governorate and is practically only accessible by road from there.

About living on mountain peaks

The main reason for using cisterns is because the settlement is on the mountain peaks and ridges and not in the lower part of the terrain where the continuous water sources are. The reasons for this peak-settlement tendency has mainly to do with two factors:

1:Building is, and especially was, a major cost. In order for the buildings to be safe from floods and rock-fall, the steep reaches have to be avoided as do the wadi bottoms where some places are indeed wide enough for settlement, but also are far more flood-threatened. The mountain tops also provide a strong foundation for large masonry buildings. Lightening during the tropical rainstorms is the only natural disaster that can affect them and sometimes it does happen.

2: Perhaps the most important factor is the need for security in a society traditionally without a strong state. This was especially true for those owning land and property. By looking at the soundness of the mountain villages compared to the crude and small buildings of the tenants and tribes living in the same landscape but in the lower half, one can easily see how the buildings are made strong and grouped together as fortifications sometimes having only one door to the inside. Before heavy artillery became available, such village fortifications could through village cooperation withstand bandits and raids from other tribes. The most elaborate houses are sound masonry buildings several stories high. The richer families in these houses owned much of the land, even the irrigated land along the main wadis several hundred meters below. They never and still rarely intermarry with the people in the lower wadis that are still sometimes called “badØ” (nomads, connotes having low material standards). The topographical height often coincides with political power. Making sure that not anyone could simply come and take that away, necessitated strong buildings and the strong buildings showed what you could afford and thus be capable off holding onto. In a “Foucaultian” sense, the power was inscribed in the monumental mountain villages. Today they still radiate power, but the elites invest mainly in the cities and local agriculture is not the important resource it used to be that needs to be controlled. Using rainwater harvesting cisterns has the function of having water where it is needed; it eliminates some of the carrying from lower altitudes and provides the safety by sharing its management with those you have face-to-face relations and share the matter of security with.

2.2 Types of water use in the field area

Fig. 6 A well in the very northern end of the field area, in the northern half of Murdhaba, the altitude in the wadis are down to 600 masl. This implies that the temperature is very high and the climate much dryer. There is almost no agriculture and little settlement. The most important activities here are goat herding and beekeeping often performed by semi nomads. In the wadis there is always a subsurface base flow and shallow wells provide all the water needed. They might dry up in periods. When the water flows for some hours as a flash flood after a heavy rainstorm upstream, the main problem is that large flood might reach the well and bury it. It is a large problem and causes a lot of work for the locals to dig it out again. This labour makes the well semi private. The thorns around the well are widely used as fencing. These wadis are important transport ores as they function as car roads.

Typology of water use in the field area

The classification of the different water usage could be based on categories of source, geographical distribution, scale or amount, but all these categories are often very interconnected. Since the water landscape is very complicated, it has to be presented in a very simplified model form where the types of water use is based on a combination of different categories.

A: Traditional

(a) Agriculture:
1 Runoff supplementary irrigation
2 Medium and small scale sayl (flood) irrigation
3 Spring irrigation

(b) Domestic:
4 Traditional spring
5 Traditional cistern

B: Newer technology

6 Public Waterworks
7 Qat irrigation from large new private cisterns
8 Water trucks as transport from various sources
9 Use of hoses and pipes
from cisterns
from springs of running water

The rest of the presentation of types of water use in the field area will follow the typology above. (2) Is very similar to (1) and will be described together. The spring irrigation (3) is described further below under “The spring cisterns”. Public waterworks (6) has been dealt with previously, under the description of the field area. Qat irrigation from large new private cisterns (7) is dealt with later under different types of cisterns. The use of water trucks, pipes

and hoses (8 and 9) is best described in relation to new technology and is discussed in part three. Thus the remaining two types will be described subsequently:

Runoff supplementary irrigation (traditional)

Domestic water supply (traditional)

Fig. 7 Small scale sayl irrigation.

It simply consists of canals leading off a minor wadi or flood course. In the picture it can easily be seen that the terraces that directly receive the water from the canals, are much greener than the subsequent ones and those located above the canal. The intake dams are constructed to break if the flood is strong in order to ensure an amount of water that the outlet drainage capacity of the field can handle. This is especially important if the field is located far away from the home as everything has to function without anyone present. If the terrace holding the field is breached, much of the terrace soil might be washed away and lost forever. The farmer owning the field will also own the water rights to the flood course. He has to give the next user down stream the flow of water when he has satisfied his own needs. There is practically no way to withhold more water than can be stored on top of the field by the field bund anyway. The height of the bund is usually 10-40 cm high. When the field is full the water will spill over a specific place called manshar (spillway) that is lined with rocks so erosion will not occur.

Fig. 8 A very clear stone made collection canal for supplementary rainwater harvesting. The fields in the picture rely on direct rainfall, but the collection canal increases the water supply. The first terrace receiving the extra runoff is clearly greener than the others.

Both pictures refer to the same concept, but fig. 7 refers to a system where runoff is gathered from a flood course where the catchment itself might be slightly distant and fig. 8 purely from an area without connection to a water course. If the runoff is already gathered in a watercourse and the flood is diverted, this is called sayl (flood) irrigation in western academic sources. If the water is gathered from an area without a visible flood course in it, it is called supplementary rainwater harvesting. The important point here is that these two categories almost overlap as one phenomenon, much because of the very small scale of most of the sayl irrigation in Hajja and the local terms used in both ways are very much the same. Helmut Eger (1986) wrote a PhD thesis from Amran, a neighbouring highland governorate, where reliance only on direct rainfall in agriculture, as is possible in Hajja, is impossible due to the area's location further to the east behind the rain shadow. Gerhard Rappold (2004) also wrote a similar PhD from the Ta'izz area and one of his main findings is that even cases where agriculture based on direct rainfall is possible, extra water during the early plant stages greatly enhances the crop's growth. The water stored in the soil can get the crop better through the

dry season during mid summer between the two rain seasons. The soils storage capacity depends among other factors on soil type and depth.

Both these methods of irrigation may also be used in gathering water for cisterns, although using water from a flood course is not as common since many cisterns lie in the higher reaches. The former method might have more shareholders to the water rights, as several individuals might own a part of the right to take water from the flood course. The upstream user always has the supreme right over the downstream user in such cases. This seems to be rather consistent throughout Yemen.(Varisco 1983b) In Hajja there are no large scale sayl irrigation schemes like those found where the wadis drain onto the coastal plain.

A very significant problem concerning the flood courses is that some of them seem to accumulate far more sediments now than they used to. In Wadi Shiris, only wealthy farmers can afford to make strong walls to keep the floods out, as the flood bed itself has risen several metres according to locals. It is common in western academia to blame this on the many terraces that have been left and fallen into desrepair especially during the 70's when all the men travelled to Saudi for work. The locals also give road building as a cause for this problem. Newer roads are generally made quite broad and cut into the mountain side and the leftovers are washed down into the wadis. It is not always possible to find a correlation with either abandoned terraces or road building within the wadi catchment as a cause for the phenomenon. One informant said that the wadis had always transported sediments but that the reason for the "problem" was that the farmers are not as diligent as before in keeping their walls and water structure "updated" to the rising wadi floor. The agricultural fields are also rising as they receive water with a high silt content. This has not been investigated further in detail, but there seems to be large differences from wadi to wadi.

Traditional domestic water supply

By *traditional*, I here mean the technological situation in domestic water supply before the revolution in 1962. However, the picture I describe below is from present time, but I describe the situation today with its very much unchanged traditional water management practices. The traditional practices form a basis that is seldomly used in the city, but almost unchanged in villages with no road connections.

Traditional domestic water supply has two main sources; well and springs. As mentioned there is a significant part of the population in the field area without a permanent piped water connection. Therefore, the traditional sources are still very much in use. Those villages that have a rough or no road connection, have no other means than relying on the traditional sources. Other villages connected to roads can supplement their domestic water need by truck.

The general condition of the cisterns was in decline during the civil war (1962-1970) and during the 70's when a high percentage of the men in the field area worked in Saudi Arabia, the cisterns were not maintained. The population increase and economic deterioration during the 90's made the locals face a situation of a historically high water demand, with even less water available per capita than ever before. Some villages restored their cisterns, but in many villages the families better off bought water by truck or made their own cisterns. As a result, many of the public village cisterns are today still not restored and cannot hold water. A small to medium cistern of 4m diameter and 4m depth costs circa 100 USD to re-plaster with cement, according to a very rough estimate. This seems to have been too high a price, as few of the poorer segment of the villages could afford to spend so much money on such a long term investment. The result has been that the poor would supplement with more domestic water from the springs.

As the springs are generally located far below the villages, this has caused much more work for the women whose cultural responsibility it is to provide water for the household. In periods when the cisterns run dry, the women walk down to the springs or wells in the wadi, sometimes several hundred metres. Water is used extremely sparingly, for example is 20 litres a day per capita a common water consumption level and this even includes water for the household cows (1-3), donkeys and hens. Washing is kept to a minimum and is rather done by bringing what needs to be washed down to the springs.

The springs are usually used in *traditional spring irrigation schemes* (see page 61), but there is a law stating than anyone in need of water can take for domestic supply. Practically speaking, this is a truth with modifications, as some springs are more used as common water supply than others. In certain areas, for instance in Hirba, the main common spring is hardly used for irrigation anymore as the 2000 inhabitants in the area get their drinking water from the spring, and towards the end of the dry season when the cisterns are empty, most water is fetched from here.

Roof water harvesting occurs, but to a very varying degree. Water is usually stored in the tanks originating from the piped public works systems and these can be bought and transported easily, but rarely hold more than 1-3 m3. Roof water harvesting is considered rather clean and thus reduces the need to carry water form the springs, at least during the rainy seasons.

Fig. 9. Roof water harvesting is found in the field area, but is not very common. Problems of private nearby storage capacity and small roofs compared to the house size, are problems mentioned by the informants. The drainage pattern on old houses is also a problem; the walls in the houses project up through the roofs and divide the roofs into sections that each drain through different gutters on each side of the houses. Old roofs also have sand cover that will not produce as much and as clean runoff as concrete. There is a small tap on the water tank and it is always locked with a small padlock. Note the pots with herbs and flowers on the side-roof; the roof is namely the only flat, goat-free surface and may be used for many different activities, including drying clothes and out-of-reach storage. According to informants, this is one of the reasons for the general lack of roof water harvesting.

Purchasing water by tanker is an option in most villages as it is common to have a road connection. However, the roughness of the road makes the overall price of water per litre rather expensive. For poor people especially, water is not purchased, but rather the “need” is reduced. However, water is bought by those who think they can afford it. Water supply by truck is far more common in cash crop irrigation of qat. It is not uncommon to buy water for

qat irrigation, but still let the women carry domestic water up from the springs. This separation of domestic and economic water spheres is discussed in part three.

Springs often occur in small narrow wadis and many of them have some similarities with wells. They have to be slightly dug out and often need a wall or structure to protect from heavy floods. Many springs get re-covered by sediments after each rainy season. Today, thin plastic hoses are often used to suck up the water from such holes in the flood bed by the principle of siphoning[18]. This allows for the water to be collected and even stored in an appropriate place nearby. Sometimes money is invested in a larger dam of stones to protect the spring and lead the flash flood around the spring. This is also the reason why there are virtually no dams in the area; flash floods are so strong and carry so much and coarse sediments that the dam would quickly fill up. The only local way of storing water is in a cistern located away from the flood course in the wadi. Plastic hoses between the spring and the cistern is a new innovation that before was not available, and these springs could often not be utilised.

Springs that yield a significant amount of water, have during the latest years been subject to a rather new development; plastic hoses or galvanized steal pipes up to circa two inches thick are placed in the spring and transport the water to areas where it can be more easily used as irrigation. Some springs are located in steep terrain with only little arable land underneath. Other times the water appears at a rocky threshold in a wadi before it immediately disappears again under the sediments in the flood bed. Where this is the case and the wadi is narrow the water could earlier not be utilized. If it was utilized in the past, the increasing amounts of sediments in the wadis may very well have buried the agricultural land and using pipes from the spring to a new area is the only way of utilizing the water. Pipes coming from such springs represent a rather new way of using water, however according to informants it will still be distributed according to the same rules among the same shareholders as before. However, undoubtedly can those who financed the pipe get a better share than before.

Before moving on to focus on the cisterns, I want to briefly mention erosion protection and floodwater drainage. Protection from water is actually a rather important aspect in the field area, as rainfall can be extremely heavy. Most of the infrastructure has to be planned with this

[18] In Norwegian: hevert

aspect in mind. Not only is it an important part of water supply structures, but also when building houses, agricultural fields and roads this has to be taken into consideration. The practical local knowledge of erosion safety seems to be very well adapted to local eco-technical constraints and possibilities. When erosion or degradation does occur, it has other causes such as uncertainty of ownership and responsibility, or problems of economic ability to invest in larger structures. Traditionally, erosion management has been a part of water management. Flood and drainage courses[19] that pass through agricultural areas are perhaps the best example of this, with elaborate guiding walls and "steps" made of large interconnected stones in order to safely guide the water down the mountainsides without causing damage to nearby agricultural fields. Some of these drainage canals pointed out by the informants, are said to be several hundred years old and have not been subject to damage in the time-span of collective memory.

[19] Sometimes called shuôb

2.3 The cisterns; practicalities and use

A cistern (birka, birak) in the field area is, in the narrow sense, the storage tank or basin in the local traditional typical rainwater harvesting system. In a wider sense, the cistern is the entire rainwater harvesting system where the tank is only one of the other functional parts, such as the catchment area and the collection canal. There are other types of local traditional rainwater harvesting that are mentioned in some of the earlier chapters. In this thesis, a cistern is the name of a quite distinct and widespread type of local traditional rainwater harvesting system described in this chapter.

Despite showing some variety, the average cistern is here presented in a simple model of a cistern seen from above:

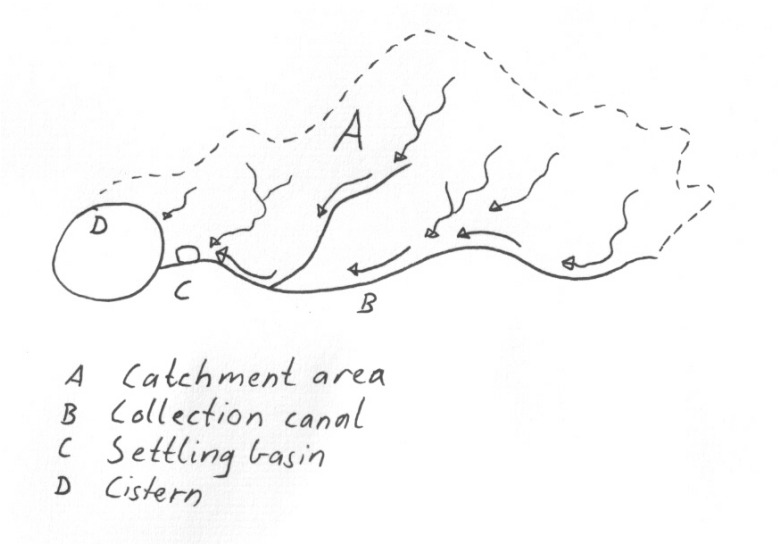

Fig. 10 A model of a cistern with its catchment area seen from above.

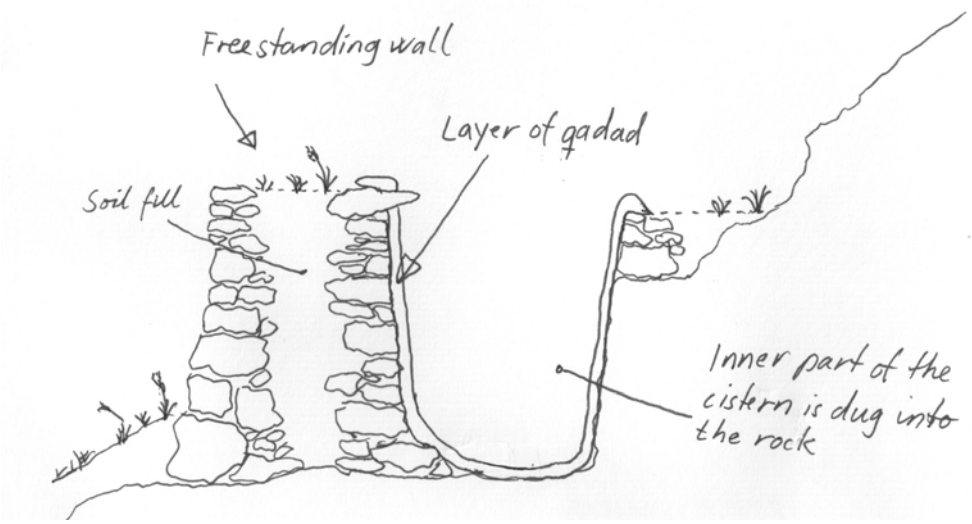

Fig. 11 Cross section of a cistern. Sizes vary much, but a typical size is circa 5 metres in depth and circa 5 metres in diameter at the top. The walls slope somewhat inwards toward to bottom. This type is semi dug into the rock as the terrain is steep. If the terrain is not so steep the whole cistern is dug out, but may still have masonry and most certainly have qadad as an impermeable plaster (see further below). The stone at the top that projects out some decimetres and has the shape of almost a small diving board, is called sindfa and is used when pulling up the water and bucket with a rope.

The catchment area[20]:

The catchment area is represented in fig. 10 as “A”, and the circle “D”, is the open storage tank or; cistern. Direct rainfall into the cistern would simply not be enough in means of water supply. If it rains 500 mm in Hajja annually, theoretically, the water level would only rise 50 cm. But if a catchment area is included, that together with the cistern’s surface has an area that is ten times larger than the surface of the tank itself, the water level would rise 5m in the cistern.

Several complicating factors must be taken into account as well:

1. Distribution and amount of rainfall over time: If rain fell continually, no storage tank would be needed. The cisterns function as a storage tank that level out the temporal distribution of rainfall against the steady day to day consumption. In the field area, they are made to store water for the dry winter half of the year.

[20] *The catchment area* does not seem be a concept that has a local name, as opposed to most other parts of the cistern.

2. The runoff coefficient is the rainwater's infiltration into the ground in the catchment area. Sandy soils will produce runoff only during very heavy rains compared to bare rock that will not absorb any water. Also, the vegetation, the steepness and the quality of collection canals are some of many other factors that can play a role.

3. Evaporation from the cistern: Krämer (2003:35) shows that circa one third of the water volume in an average cistern could be lost if the cistern is uncovered, as is typical in the field area. In the water storing winter season this means circa 2500mm of evaporation. The wind may increase the evaporation. His calculation does not include the protecting factor of the floating plants. The archaeologist Jorge Marcos (Marcos 2004) argues that floating plants reduce the evaporation significantly and that the locals in the Santa Helena Peninsula at the coast of Ecuador, deliberately put floating plants in their *albarradas* to reduce evaporation. The albarradas are a local from of large horseshoe-shaped dams for rainwater detention. The opposite, namely an increase in evaporation due to the floating plants, is often stated in literature about the spread of the problematic water hyacinth. A differentiation of this picture is given by a web page from University of Florida Center for Aquatic and Invasive Plants (2004). Here, it is stated that the water hyacinth increases the evapotranspiration by 1.26 – 2.7 times, whereas the duckweed reduces the evaporation by 0.85, as the leaves are smaller and floating on the water itself. This reduction is perhaps even bigger if there is wind in both alternatives; with and without duckweed. The floating plants in the cisterns look as something close to duckweed. The informant opinions differ about the use of the floating plants; some say that "it prevents the wind from taking the water." In private cisterns, however, the floating plants are usually skimmed off. Roof covering is an important topic in terms of evaporation reduction, but also in safety measures.[21] Roofing or covering of the cisterns is not found in the field area, except in a few historical locations and some few private cisterns are covered with wooden beams and corrugated iron.

The factors above are often presented by experts in mathematical formulas. However, there are several additional practical factors that the locals have to consider when maintaining or building a new rainwater harvesting cistern:

[21] Almost every second cistern has a story of drowning connected to it.

1. Seepage or leakage: It is easy to think that why should a cistern have to leak at all, but it seems that most of the old cisterns leak, more or less. Creating a new cistern that will never leak seems almost impossible with the available technology, and there is always a risk of future leakage. The informants have a slightly fatalistic attitude toward this topic, and this is understandable as leakage is a hidden defect caused by several factors that might lay behind the plastering and even masonry such as a failing foundation etc. It is a type of knowledge where cause and effect is not very apparent, as treated further in chapter 3.4.

2. Flood hazard: The cistern and its collecting system must be protected form severe rainfall. This is achieved by constructing safety vents or spillway in the canals before vulnerable stretches. These are simply called “diversions” (tasriif). The cistern also has to be located away from a flood course.

3. The landscape may contain topographical challenges: steep terrain, hard rock that cannot be moved away where the canal should have passed etc.

4. Practical limitations of the tank’s size in a very steep environment with limited building methods.

In addition to all of the factors above, come the social and cultural constraints that lay upon the actor that would like to change a cistern or construct a new one (mentioned in part 3).

The point with the fig. 14 is to show how minor and subtle the use of collection canals may be, and that the terrain can, in some areas, be completely regulated when it comes to runoff. The runoff catchments only collect all the runoff during light to medium rain. In heavy rainfall, certain parts of the collection system will break and the full amount of possible runoff will not be collected, but let go. There is a balance of how much water can be collected, for which price, taken into consideration a wide range of rainfall intensity as well. This complexity is rarely taken into consideration when experts such as engineers write about rainwater harvesting. Having collection canals that will break before an “ideal” concrete structure would, necessitate a larger catchment area than what would be theoretically sufficient. But it also provides the downstream riparian neighbour with more water in heavy rain.

The collection of runoff by using collection canals

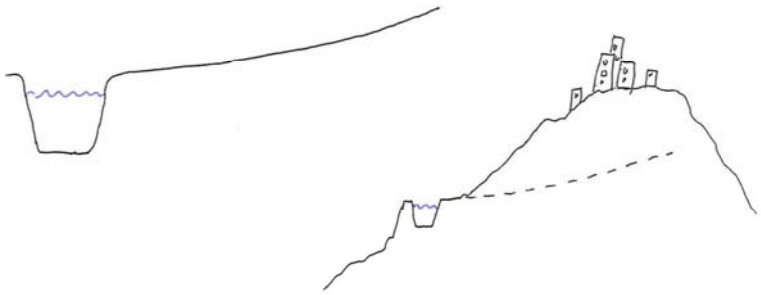

Fig. 12 A simple cross section of a cistern and its collection canal. The second figure shows the cistern's typical relation to the village with its problematic aspect of collecting biologically contaminated runoff.

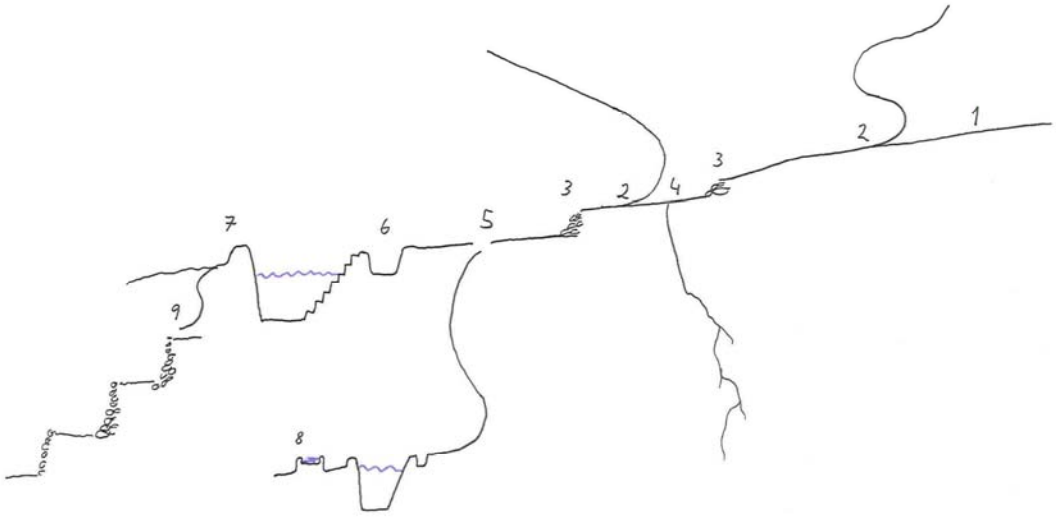

Fig. 13. Cross section model of a collection canal and some of its details:

1. Main collection canal

2.Tributary canal

3. Steps of stone to control the inclination and hence speed of the water

4. Spillway or safety vent that will break in case of heavy rain

5. Diversion point for a canal to a second cistern using the same catchment area

7.Spillway at the cistern

8. Trough for watering animals

9. Reuse of spill-over water for irrigation on terraces.

Figure 12 and 13 are models of the transverse cross section of a cistern. Due to the steepness of the terrain in the field area, the collection canal is almost always located along the lower edge of the catchment area quite similar to the position and function of a gutter to a roof.

The catchment area is usually close to the cistern and only rarely does the collection canal also have a function as a pure conveyor if the catchment area is a located apart for the cistern.

The collection and conveyor canal have many names as mentioned in appendix 4.1, but is usually called masqa (pl. masaqi).

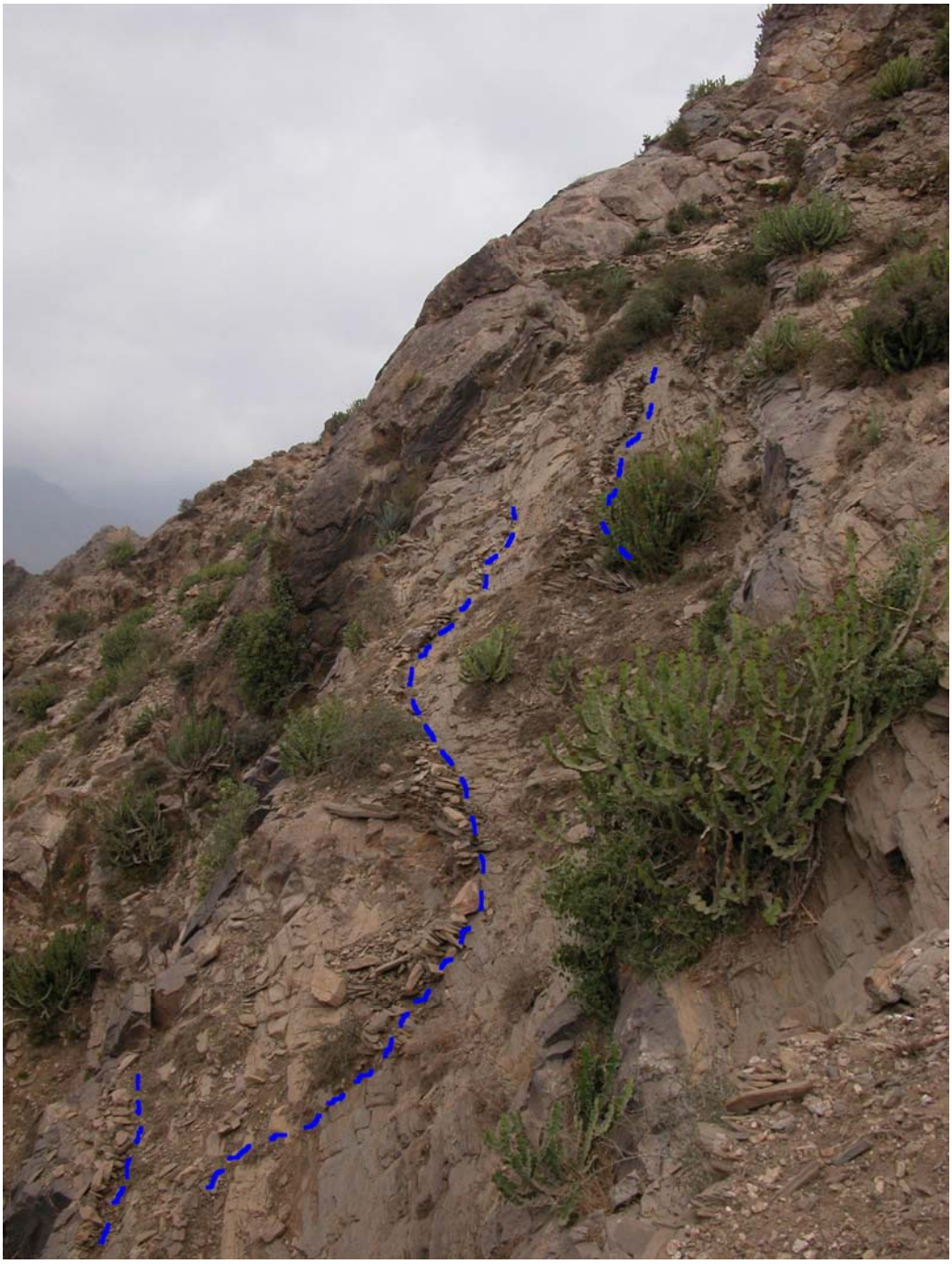

Fig. 14. The beginning of a minor collection canal. The potential water leading ability is indicated by the blue colour. The canal is very simply constructed by using rows and simple walls of stones as a guiding wall along the bare rock. When the water comes sand will partly fill the holes between the stones and make it more effective. This canal is very minor and is commonly used to guide runoff to agricultural terraces. This picture is taken in a low, eastern facing, dry area.

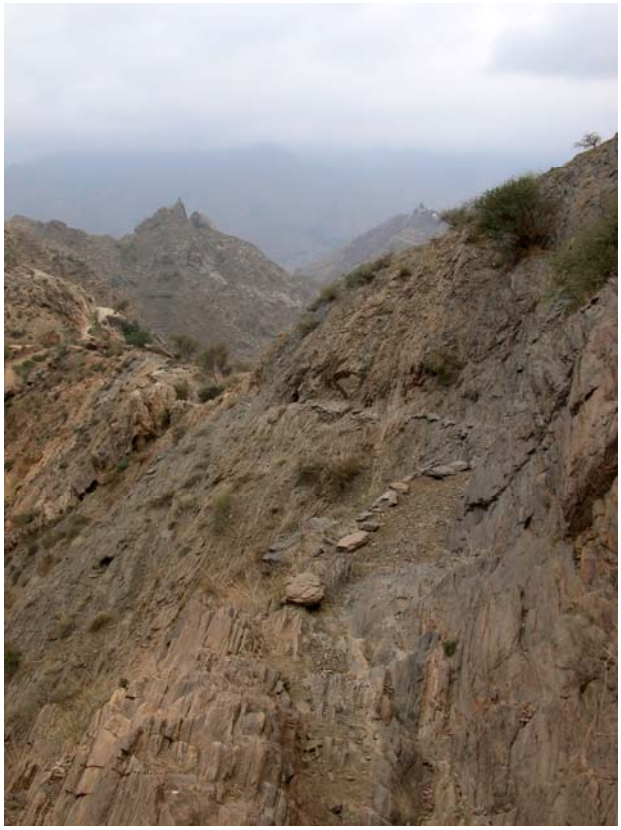

Fig. 15 Left: A major collection canal passing an aqueduct and can be seen extending upwards with a steady inclination. If collection canals are strongly built, it is common to use them as roads passing by otherwise steep sections. Here, it can easily be seen that it needs to be cleaned out and made deeper if it should convey more than a very small flow. The outer edge gets worn by people and animals.

Fig. 16 Right: The same canal, viewing downstream, is hewn into the rock parts of the stretch. It was said to be several hundred years old.

About half of the cisterns have some form of stairs leading down the inside of the cistern. Sometimes the stairs do not lead all the way down to the bottom. One informant said that cisterns without stairs were considered more clean, as animals could not descend and hence pollute the water. The traditional cisterns without stairs often have a large stone projecting out from the rim of the cistern like a diving board as drawn on fig. 11.

2.4 Typology of the cisterns

The different cisterns may be classified in different ways: According to function, form, size, ownership and so on. I have chosen here to categorize according to a combination of usage and ownership and then mention some "side line cases". The typology is a presentation of generalized models of the main cistern types with pictures illustrating actual cases. The reality however includes many cisterns that can have more complex usages than those described below.

(1) Spring cisterns

Fig. 17 The picture shows the two biggest spring cisterns at al-Maôayn, just below the city of Hajja to the north. Note the plastic hose that is siphoning water out of the cistern leading it to an adjacent qat field. It was said that the Imam used to come here for picnics during afternoons. People consider it a beautiful spot and say that some years ago it was much more than now frequented as an outing place. Just above the picture to the right is the spring itself, located where people are entitled to fetch domestic water and women come here to wash clothes. If the setting is private, people also prefer to wash themselves at a spring where water is plentiful and clean. The springs are usually located far below any nearby settlements and water consumption is limited usually to drinking water due to the constraint of carrying the water.

Spring cisterns in traditional spring irrigation schemes: In the landscape one can see small oasises of fertile forest growth anywhere in the lower reaches and often close to wadis. These green patches of forest are very delimited spring irrigation schemes that have been used continuously for centuries. The water structures here are the spring itself (ghayl ghuyūl), a cistern and a distribution canal network. These cisterns are often called maḥjil and not birka, but the distinction between the names is not always made. A spring cistern has nothing to do with rainwater harvesting and has some distinct features: Firstly it is located very close to a spring that slowly fills the cistern at an interval between hours and a couple of days. It is only used in irrigation schemes like the one very accurately described by Varisco(1982a). Secondly a maḥjil always has a small hole in it through the outer wall at the bottom. In this hole a piece of plastic or a flat rock and mud is placed like a cork. This hole is rather small, but bigger on the outside, and this type of cistern needs to be built with one free standing wall so that the hole is accessible from the outside. It also needs to be placed above ground level so that water can drain out by gravity. When the cistern is full, a pole is lead through the hole from the outside and the blockage is poked open. The emptying of the cistern typically takes around half an hour. All the water is thus freed in one pulsation and this makes it possible to convey the water through numerous canals, cross points and between other shareholders' terraces, onto their respective pieces of land, without a very large loss of water. If the trickle that comes into the cistern from the spring was to be led directly to the fields, everything would be lost in the unlined earthen canals.

The diversion points are controlled by temporary blockages of soil, and both these and the canals may seem very crude as seen in fig 18. Due to its long duration of usage throughout history in the area, the amount of water available in the spring is usually complemented with a certain amount of land, and access to land in the scheme simultaneously gives access to the water share needed to grow the locally adapted and culturally rational crop. In Hajja this is mainly coffee. Large trees are often used to give shade to the coffee trees. Such schemes can have a multitude of owners and sharecropping arrangements including waqf (see part three). This mix of owners makes innovation difficult as many of the actual owners never meet and the tenants may see change as a threat to their jobs. Land tenancy over a prolonged time often leads to the *right* to rent the land in the future. A fixed sharecropping price is common, for instance it is common in the area the tenant have the right to one third of the coffee harvest.

Fig. 18 The thin trees are coffee trees and the large ones are used to give shade. Local herders also cut leaves and small branches for the goats and sheep to the annoyance of the land owners. Note the crude canal along the inner edge of the terrace used for conveying water from the cistern.

The ineffectiveness of traditional irrigation schemes is a major contribution to springs and local groundwater resources further downstream. If drip irrigation was used, or an irrigation regime enhancing minimal water loss through downward infiltration as drainage, many of the small springs downstream would undoubtedly dry up. The local perception of such micro groundwater dynamics is characterized by the fact that groundwater is a “hidden and mysterious” resource. It is a topic where knowledge cannot easily be practically tested by a single actor.

Since I was often perceived as a potential source of development aid, I was sometimes asked if I could donate money for pipes. Today, the actors that can afford it, try to separate out their part of the water and transfer it to more distant lying land where the land water ratio will be more in favour of qat and hence a better value/water ratio. Today, even thin hoses are used to either sell the water directly to trucks or to irrigate distant lying qat fields. This adds a new complexity to the use, value and management of the spring irrigation systems.

Especially the users that own land farthest away form the spring, have to endure heavy water losses in the traditional canals. If access to land is restricted, coffee is still preferred as the cash crop and in lower altitudes mango and fruits are more common. Most irrigation schemes are only semi-dependent on the spring. The spring can for instance prevent coffee from drying out, but the main bulk of irrigation may come from rainwater harvesting such as a diversion from a small wadi. There is thus a need for simultaneously overlapping canal networks of spring water, flood water, and flood drainage. In Wadi Shiris, most of the irrigation comes from a main strong perennial spring in the wadi bed itself and no cistern is needed. But even here, more irrigation water is harvested if possible when the wadi floods.

The eco-technical aspects related to the use of spring cisterns can be very complex. The delimitation of this study is placed on the rainwater harvesting cisterns and I will leave the spring cisterns and the traditional irrigation schemes here and refer to Varisco (1982a) for further details about spring irrigation.

Finally, traditionally there were no waterworks in Hajja city and drinking water was carried from one of the springs below the city. These springs were used for agriculture but there was a protection zone[22] where anyone could fill their containers before the water flowed into a private collection cistern in a spring irrigation scheme.

(2) Mansûriyya; cistern without qadad

A peculiar type found, but not common in the field area is a type locally called mansûriyya or nâsiriyya. Since they are so few this could also be local names. The outer half of the wall is free standing but the cistern is also dug into the ground. The main difference of this cistern compared to others is that there is no plaster used to make it waterproof. The walls are crude masonry and the outer wall is partly freestanding and double, filled with soil. Two such cisterns were seen near ôAjrama, Mabyan and one between Hajja city and Qudam. The soil filling needs a special quality to be impermeable.

[22] The buffer zone is called "harîm" according to Varisco (82:253)

Fig. 19 A mansūriyya type cistern between ôAjrama and Bayt Shāmah in Mabyan. It was said to be 7-8 m deep and it is somewhat wider that that across. Note the complete absence of plastering. The inlet canal is from the middle of the bottom line of the picture leading to just to the left of the man in white. The canal has a “step” down, close to the lower edge of the photo. This detail is called ôUgala and is described in part 3.3.

(3) The traditional city cisterns

The city cisterns have fallen much into disuse and therefore I have chosen not to focus much on these. The only ones left visible and unburied are much larger than the average cistern in the villages. The cistern at Dhahrayn and Birkat al-Nāṣiriyya below the market (see fig. 20 and 21), are probably not that old and may have been built with more expert knowledge since the city of Hajja has been a provincial capital and at least a centre of administration for a long time.

Fig. 20 Left: The cistern at the quarter of Hajja city called al-Qalaôa. The cistern is empty and has just been cleaned out. The water enters through the presently closed hole at the top of the stairs.

Fig. 21 Below: The cistern of Ðhahrayn, nearby. Both cisterns are today used by individuals for harvesting water that can be sold to tankers for about 1 USD pr m3. Officially, they are public property once donated by someone with attached management guidelines (see part 3.2, waqf).

(4) Cisterns inside fortresses

The area is full of fortresses and also villages more or less planned as fortresses. Sufficient water capacity for sieges has been a very important factor and there are usually cisterns present inside all fortresses and fortified villages. They tend to be more detailed and sophisticated and shaped adaptively to the varying conditions. Sometimes they can be like small dams in a crack in the mountain.

(5) The mosque cisterns

Fig. 22 Mosque cistern at Jabal Sūd. As there is no piped water here, the cistern is still used in a traditional way. The two “tunnels” leading down to the water surface are used when descending the stairs to perform the ablution in a private setting at varying water levels.

Every village has a small mosque, usually square, without a dome and painted white. Every mosque always has a cistern made for the ritual pre-prayer cleansing, ablution (wuḍūʾ). Since the water is not consumed, only a small catchment area is needed and usually consists of the

roof of the mosque and the courtyard itself. If the mosque is medium or larger, one or more "tunnel-structures" are used for washing inside for the sake of privacy. The water is quite green, has a smell and is obviously not as clean as preferred since if possible, the believers would rather use water with the quality generally associated with water from public waterworks. The mosque cisterns are usually more elaborate and have more qadad details (see chapter 2.5). The cistern for the central mosque in Hajja is quite large and was full of children swimming and women holding ropes leading out to the youngest ones as a safety measure. The water was never changed.

(6) The village cisterns

The village cisterns can be divided into these groups:

(A) Public, located near the village for household use. These are used for either drinking, household water, or animals or a combination of all these. Of this type there are two subtypes: (a) Small type appearing numerously 10-40 and (b) Big type; one major cistern for the whole village plus smaller supplementary ones.

(B) Public, located far away from the village for grazing animals. Often not only owned by one village, but herders from farther away, "pastoral tribes", may also use them. They might be officially owned by the village or tribe that owns the pasture, but may still used by "clients" useful to the village or by a group having traditional usufruct rights.

(C) Public, old roadside cisterns for travellers[23]. They are often owned as waqf, that is, donated for the good of the community as mentioned in part three. In the case of travelling, any traveller can use them, not only locals. Today, this type is perhaps the one least maintained.

(D) Private cisterns seem to be something relatively new. There are two types: (a) Old public cisterns that have been bought by an individual. They may be located close to the village, but often they are at some distance, as the "best" locations are not sold. At the same time since

[23] They only exist along traditional roads, not modern car roads.

they are often used for household use and even drinking water. They are located at some distance and with relatively clean catchments. This is a seldom type and generalisations are hard to give. (b) New private cisterns. They tend to be large, used for qat irrigation and often located in relation to the owners' qat fields and possible runoff. A subgroup of these are the ones located close to a car road which represents a new way of capturing and conveying runoff, e.g. the roads drainage water.

(7) Private large new cisterns for qat irrigation

If someone has the financial means and wants to invest in local land, one strategy is mentioned by all farmers: providing water to irrigate qat for sale in the market. This is done by the wealthier in each village. However some villages and areas, especially those with good road connections, have a much higher qat related agricultural activity. After the tarmac road to the capital came in the 80's, Hajja became part of the national qat marked. Qat needs to be fresh, and the time between picking and consuming should ideally be one night and the following morning, not more. The whole of western Yemen exports qat to their respective nearby cities, but also to the capital. There is a government tax on the trade and is not considered illegal at all. In the countryside above 1000 masl, qat is the absolutely most important cash crop. Coffee, the traditional cash crop in this zone, is still grown, but farmers mention that the advantage of the coffee lies not in the high price, but in the stability of price. Provided that one has little water, but much land (as opposed to the situation in traditional irrigation schemes), qat is the rational crop to grow. It is very drought resistant and will yield at any time of the year depending on rainfall, or after 2-3 weeks of sparingly irrigation. This implies that in the dry winter season, when qat prices area high, the water price in the field area can reach more than 5 USD and still be worth using for irrigation. This figure is supported by a study about economy of qat production with data collected from several areas in Yemen (Abdullah, Gatter and Malik 2000). Obviously, the high water price during winter puts a pressure on domestic water price as well.

Fig. 23 Medium sized new private cisterns for qat irrigation. The cistern irrigates the qat that can be seen adjacent to it. The water is collected along the road toward the cistern and through the settlement basin in the end closest to the camera. The picture is taken during late spring before any heavy rain could fill it. The small houses are guard rooms as the crop is guarded from thieves during night, even close to villages. The water has to be pumped by a small portable petrol pump to irrigate all but the lowest terrace as the cistern is located at the same elevation as the terrace closest to the road. Such a cistern might cost 1.000.000 YR i.e. circa 5000 USD, but a price two to three times as much is also common. This picture shows a very well performed integration of a car road into the traditional landscape. Very often, walls are not resurrected and the masses that are left over from the construction, just pushed down the side. Restoration of terraces is usually only seen in conjunction with qat

agriculture. Note the runoff area to the far left that feed several different qat terraces with direct runoff supplementary irrigation.

These new qat irrigation cisterns are always private and do not have to serve the village. Indeed, it hardly happens that poor people can fetch their water from such a cistern. This type of cistern has some very specific characteristics:

They are often built to collect runoff from a road. Roads are good runoff collectors as they can cover a large catchment area inside an area that previously had fixed runoff rights. Building of new roads alters runoff regimes much as roads have to follow contours to a large extent, and a “runoff rights reform” has to be undertaken. Some farmers would simply have to give away runoff land in addition to agricultural land. In this process, wealthier farmers may intervene, perhaps together with brothers or other co-investors, and try to secure enough runoff for a qat irrigation cistern.

Secondly, they usually have quite large settlement basins. Especially those collecting road runoff, as roads produce runoff with much silt and finer sediments. This is very clearly illustrated in the picture below.

They are usually built with masonry of square-cut rocks with cement in between and often plastered on the inside with cement as well. They are often built higher above the ground than the traditional ones, sometimes half way out of the ground. The only necessity is to have the back wall low enough for the water to flow in by gravity. The more elaborate ones have a pump and a pressure basin and a fixed piped network between the cistern and the qat fields. The piped network then has connection points e.g. at every 50 metres so, that a hose can be connected and used to water each qat tree individually. Water may also be sold to other qat farmers by hoses, portable petrol pumps, or even to a tanker if the water price is high. In one village it was observed that several cistern owners shared a common pressure basin so that the cisterns collected water individually and the pressure basin was used to transport the water quite a distance away to the different qat fields of the respective owners. In that way, they did not have to undertake any significant land ownership reform when they decided to invest in the water structure, even if the suitable fields were located quite far away from the suitable runoff collection areas.

Fig. 24 Private cistern with a very large settlement basin. The runoff comes from a road.

The high area of Mabyan has a good road tarmac connection and very large tankers can carry water 1000 metres up from Wadi Shiris relatively cheaply. The area has very much qat agriculture and also has a very high density of private, large, qat irrigation cisterns. One can even see cisterns without a catchment area, depending solely on water from a neighbour qat farmer or a tanker supply. They can be constructed with only freestanding walls as they do not need to be low enough for the runoff to flow in by gravity. We are thus talking about pure storage basins. Areas with a rough road connection have to rely on small amounts of water, maximum 1 m3 transported on the back of a Toyota pickup, and this makes the water price so expensive that one could irrigate qat this way only occasionally during dry periods when the qat reaches high market prises. In such areas, rainwater collection is necessary.

Fig. 25 Below: Private cistern in Mabyan. The runoff is from a public road, one can see that the water in the settlement basin is yellow of colour and quite clear in the main tank.

Some areas of high with a high density of qat irrigation cisterns are said to exist because the inhabitants of these areas have “connections” or have had a tradition for labour migration to the Gulf area. Villages may specialize in a certain type of work, also migratory, and the villages where the men work in Saudi Arabia and the Gulf compared to those where the men work in the army, make far more money providing a chance of starting the “positive economic cycle” of qat irrigation. Having a private cistern with water for irrigation is certainly for the wealthy few.

Fog collection

The visited NGO was a local representative for “FogQuest” (see www.fogquest.org) an organisation that runs projects for fog collection several places in the world. Agricultural mesh is spanned up with gutter-like collectors underneath. Hajja has many months of windy fog coming from the west during winter. The best test sites produced almost 5 litre/ m2/day. Strong winds that destroy the collectors and the relative high costs of the water compared to trucked water from other sources, seems to limit the “take off” of the project for the time being (Schemenauer, Osses and Leibbrand 2004).

2.5 The qadad: Traditional cement and plastering for the cisterns

Introduction

Qadad[24] was an important building material in Yemen used similarly to cement today and was provable in use from Sabaic times approximately until the revolution (1962) when roads and modern cement became available. After that time it became less used and during the 70's it was no longer used in the field area. The difference between qadad and cement is substantial, mainly because of the amount of labour and time it takes to produce, prepare and apply the qadad compared to cement today. But it is always said by the informants that nothing is as strong and enduring as the qadad. In short, qadad is a mortar made from a binder of burned lime and aggregate of sand and pebble.

The data for this chapter comes from observation and conversation in field and observation and conversation with a qadad-workers' group in the capital Sana'a. Few, sporadic written sources are present and most of them are not primary.

In the cisterns the qadad is mainly used for plastering and making the cistern watertight. This necessity, that only the qadad could be used for in the past, cannot be overstressed. During the times before the revolution it was almost always used when making a cistern. It was also sometimes used as "glue" in cistern structures built of cut rocks and in other parts such as the wall, upper edge, staircase and settling basin. Sometimes the cistern does not have plastering at all; if built of cut rocks of good quality with qadad between them. And sometimes in smaller cisterns, the only qadad used, is as a layer of plastering in the tank itself without further details.

[24]Transliterated: qadad, qudad. Pronounced in Hajja dialect, and most of Northern Yemen: gadhadh

The qadad-group (al-muqaḍḍidhiḍḍin)

Qadad had many fields of traditional use in Yemen; cisterns, roofs, masonry wall gap filling, decorative details on walls, anywhere where a hard waterproof material was needed. Today it is only used in some of the country's famous historical buildings, and also if some private individuals want to restore their old house in a traditional way. It represents a forgotten tradition that is today known and used only by "experts".

Most of these experts are today the descendants from some old men from villages around Yarim that was chosen when the first restoration projects with qadad started such as the Grand Mosque in Sana'a. This was in the 80's and 90's and the almost forgotten traditional knowledge was gathered and somewhat institutionalized. The knowledge today, is held by a group of descendants from these men, and this group is today one of several working teams that are hired when the government or private individuals want to undertake restoration projects. Thus one of the important reasons for that the knowledge is not lost, has been donations from other nations for building conservation. The same can be said about the general interest in building conservation among wealthy Yemenis. The knowledge is a good example of local knowledge not being situated geographically but rather in a guild with strong family ties. The result is that much of the knowledge about how to prepare and apply the qadad on walls and roofs of buildings representing high culture has been preserved, although as mentioned, as an expert knowledge. (Al-Radi 1994)(Engineer al-Hadrami, personal communication)

Making the nura (nūra)

The qadad is the name of the mortar that consists of nura, i.e. burned lime as a binder and different compositions of aggregate in form of fluvial deposited sand (because of sorted grain size) and broken, hard rock. Today and probably also in the past, nura could be bought from the market. However, due to cost of transport, cost and the importance of freshness, the nura was most commonly made locally. Some of the informants also commented that local fresh nura was of better quality. The informants say the nura is made from burned rock, but looking into articles about this material also used in the antique world throughout history until modern times, it is quite clear that we are talking about rock with a certain content of calcium

carbonate. The calcium carbonate is changed into calcium oxide when burned and when mixed with water and exposed to CO2 it again returns into something close to natural limestone (Thomson 2005). There are many subtypes with different qualities used in restoration of historical buildings in Europe today. It is said that lime mortar can be more flexible than cement and in that way would probably handle settling damages better without developing cracks further would lead to water leakage.

The whole process of making nura took approximately 15 days and was a major operation:
The stones containing lime that were used, were usually found close to the village. The ones pointed out are usually dark grey and rather hard. They were broken into pieces smaller than a fist. The second raw material is wood for firing and the type of wood used was large raw un-dried pieces of an acacia like tree called Sidr in Standard Arabic (Wehr 1979:469). The fire was made from alternating layers of stone and wood.

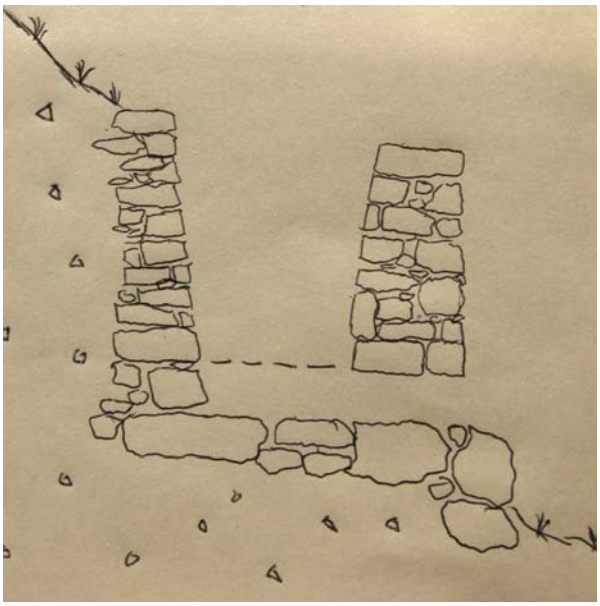

Fig. 26 A cross section of a manwar. The depth of the hole is circa 2m and the internal shape is circular

The furnace itself is called a manwar. The size of the manwar may have varied much but the one shown to me was circa 2m from the floor to the top of the wall and maybe the same in diameter. It is sometimes described by the informants as a big hole in the ground, however the ruins of the manwars shown to me in Bani Hajjar and Murqaba were dug into the slope with the outer wall of freestanding masonry. At the bottom of this wall there is an opening that is the beginning of a trench that goes into the manwar just under the floor level. The trench is situated in such a way that when the stones and raw wood[25] are piled up in layers there is a canal under the whole pile that is an extension of the opening in the outer wall. This canal was used during the igniting process by providing air and draft and access to the space underneath the pile. Constantly putting in dry wood under the main pile was done to get the whole thing to catch fire. This might have taken circa 6 hours according to one informant. A final layer of more

[25] The reason why the wood has to be raw and un-dried was never given.

broken stones acted as a final covering. After the process was self-driven, it would burn for 2-3 days with flames coming up, out of the final layer. Then the fire would still glow for 6 days. It would take 3 days for the manwar to cool down. It was left for 2 days to cool down completely. It was said that the amount of nura produced would be enough for a larger cistern or several small ones. The burning of nura was probably only done during the dry winter months.

The qadad-makers-group or qadad-quild (muqaçhçhaçhh) Sana'a stated that they always bought ready burnt nura from an area north of Sana'a. This was simply burnt limestone in pieces smaller than fist-size. When they are thrown into water to make the slaked lime, they produce enormous amounts of heat and the water starts bubbling around them, so they have to be thrown in little by little. The old men in Hajja always commented on this when they spoke about qadad, with the look in their eyes of a child's fascination, that it "boiled" (yafwr) in the thick white soup and lots of steam came shooting up. The lime is "slaked", i.e. soaked in water for some days. For fine detailed work it is slaked as long as possible. The nura will not start to harden until exposed to air. Today, nura can be bought from the market in Sana'a for a price cheaper per sack than cement.

Carl Rathjens, a geographer and traveller in the early 1900s has a short comment that in the neighbouring region of Tihama (the Red Sea coastal plain), nura was made from burned coral in a large circular bonfire (1934:14 and photo nr. 19).

The nura is most likely the same as lime putty and thus is not a solely Yemeni thing as often is being claimed; It has been known and continually used in Europe from the Romans until well into the 19th century.

Lime putty is produced by burning relatively pure limestone (calcium carbonate) at between 850 and 1,300 degrees C. The resulting calcium oxide is slaked in clean water to produce lime putty (calcium hydroxide). This form of lime cures (carbonates) by absorbing carbon dioxide, reverting to calcium carbonate. It is usually stored under water to prevent it curing prematurely. (Taylor 1999:1)

Hydrated lime or lime putty will not set under water. It is not hydraulic as is portland cement. For a lime-sand mortar to harden, it must first lose its excess water by suction to the backing material and evaporation to the atmosphere, which makes it stiff, then carbonate, which makes it harden. Calcium hydroxide + CO2 from the atmosphere forms calcite. (Thomson 2005:27)

Today, experts use lime-sand mortars in restoration of historical buildings many places in the world (Thomson 2005).

Making the qadad

The next step, how to mix the nura aggregate is not known among the local informants in detail. Sand (nays) was carried up from a wadi flood bed (sayla). There the sand is of good quality and washed, such that no fine grains and dust are present, only grains of a certain size somewhat coarser than sugar are used. Sand is still collected from the wadis for use with today's cement. This activity can easily be seen in the area where the main road crosses the wadi Shiris at Kubri.

Then hard[26] rock is crushed to pieces of circa 1- 0,5 cm. There are usually two types of rock colour, one red and one white. All this is mixed to the right mixture:

According to the informants in the qadad-group, the first layers of qadad that is applied contain a ratio of circa 1/3 nura and 2/3 of aggregate. Subsequent layers may contain more nura and less aggregate.

In other areas in Yemen, volcanic cinders are the most common aggregate to mix with the nura (Al-Radi 1994) (Engineer al-Hadrami, personal communication). Volcanic cinders or ash-deposits is a type of very light, air filled, almost foam-like rock[27]. However, one cannot see any traces of this in the qadad used in cisterns in the field area. People only mention the process of crushing a certain type of hard stone but this might be related to the apparent lack of volcanic cinders in the area. One would expect that the practice of using volcanic cinders would be easier since it would save the effort of crushing the hard stone.

The qadad-maker-group I met in Sana'a showed me how they brought sacks of volcanic ash-pieces that were being broken down to gravel size by hitting with a stone. The material is very

[26] It probably needs to be non-reactive rock, presumably a type of granite.

[27] Actually very similar to the Norwegian building block brand of "Leca."

easy to break into finer sand also and is very light and durable presumably because it is rather non-reactive. When mixed with the nura the volcanic gravel is also beaten into it.

Applying the qadad

For houses and decorative purposes the qadad may be applied in three or four layers with finer and stronger mixtures for each layer (Al-Radi 1994). However, in most of the average cisterns it seems that usually just one layer is applied of circa 2 inches. In this layer the aggregate of broken stones is very visible. Sometimes many different layers can be seen, but each of these probably originates from subsequent later repairs. The cisterns may have 2-3 layers made at the same time and well beaten together, so that it is just not possible to see the difference. Later layers usually have a slightly different colour. The first layer is beaten with a fist sized rock for a long time to adhere to the original surface. The beating process (dialect: duqq) is always emphasized by the informants as a very laborious task.

Fig. 27 Beating the first layer of qadad into the surface of gravel under. The picture is taken of a construction of a new roof in a traditional way in Sana'a. The beating is done systematically with a semi sharp edge. The part in the right corner has been beaten enough and has been made smooth. The layer is circa 5 cm thick.

The most exact information about applying the qadad is given by the qadad-group in the capital that holds this knowledge today. They said they also undertook cistern restoration from time to time. They said making a cistern is very similar to making a roof except that

large cisterns had to be made with a thicker layer in the bottom and lower parts of the walls to add additional strength.

The beating is done after applying the first layer, and if a second layer is put on top, this is also beaten into the first one. This is done to make the layers stick to the original surface and to each other. Each layer will be quite hard after 2-3 days, or at least hard enough to be ready for another layer. The mix of water has to be exact; if the qadad is too wet it will not stick to vertical surfaces, if too dry it can not be beaten into a single body without air bobbles and cracks.

Thomson (2005) also maintains that the surface behind the lime plaster absorbs some of the water once it is applied. This is important to make it quickly stronger so it will not slip of again and slide downwards. This also takes away the water surplus in the mixture, allowing air and thus CO2 into the mass. Observing the qadad-makers beating the qadad to make it adhere as much as possible, it is easy to understand how important this fact is. Even though the qadad is quite wet when it is applied it gets hard very quickly, probably because of absorption from the surface behind, and this allows new layers to be applied on top of the old ones, even before the real chemical hardening process starts. This is crucial on vertical surfaces where wet mixtures as thick as those of qadad, perhaps even two inches, otherwise, it would easily slip off. The beating by rock also vibrates the qadad around the spot that is beaten and this also frees water just as modern vibrating tools for moulding wet cement.

Toward the end of the process a final layer of pure dry nura is applied, around a couple of millimetres thick, making a very smooth and hard finish. The complete hardening of the qadad takes months. The final surface of the cisterns was probably not polished as was done to house and decoration components or at least not to the same extent. The water will chemically erode the final layer of nura anyway. Today this final layer is usually weathered off so the main layer with the red and white crushed stones is visible and projects out of the qadad a couple of millimetres. However more sophisticated cisterns might have settling basins and other details in a beautifully smooth surface, often with patterns made by a brush in shapes of overlapping 8-shaped strokes (see picture).

Fig. 28 Birkat al-Ðhahrayn, city of Hajja. The final layer of nura has been given 8-shaped brush strokes. This proves it was not polished. Some very simple cisterns do however have polished parts. This is taken just above the water line and in the lower right corner one can see the etching of the water. A similar pattern was found on other cisterns.

Fig. 29 The up-facing part of the rim of a cistern. Several thin layers can be seen, also with slightly different colours of the aggregate stones. The red part in the middle has probably been polished as one can see that all the aggregate stones are level and smooth. The aggregate stones are rarely larger than 1 cm.

Often many different thin layers have been plastered on problem areas of cracking or perceived leakage. It is often hard to determine which layer was applied first. The bottom area has been in contact with water for the longest period of time and is often completely weathered away. Usually these cisterns do not hold water at all and are left unused.

According to the qadad guild, on qadad restoration objects today, there is a practise to cover the surface when it has dried for a couple of months, with animal fat or bone marrow from cow. This is said to be done to protect the qadad from the first rain season as it takes months to get completely hard. It is said to just get harder and harder (yishtadd) after that.

Fig. 30 Talking with a farmer on Jabal Ibrahim, Himlan. Different layers of qadad can be seen as the water has throughout history etched the qadad away and new layers have been added. In the lowest part one can even see the masonry behind the qadad. According to the farmer, the cistern was in need of repair as it was leaking too much, especially when more than half full. Note the layer of floating plants, probably a type of duckweed.

The topic of qadad is a subject that interests many of the informants, and many comment that it is a long time since they last thought and spoke about it and that they only heard some details about it from the generation of their grandfathers. The long and heavy process of

making and applying the qadad is always pointed out by the informants. It is also always commented with emphasis, that "the qadad is even stronger than cement". I interpret this "standard comment" as a proud expression of how the forefathers put effort into building the infrastructure that is still in use today. Since this is so often commented upon, I see it as a part of the "knowledge about the past" and a type of local historical fact that is used in telling a story of proud heritage. It was an easy and "positive" topic for me to talk about as an ignorant stranger and foreigner, and it awaked respect when I ask detailed questions.

The shift towards cement

When asked about the last time qadad was used, the answers given indicate some time around the beginning of the civil war (1962). "When cement became available the use of qadad stopped" is the answer often given. The work migration to Saudi Arabia during the 70s probably caused a stop in maintenance and rebuilding of cisterns as people foresaw more modern ways of providing water in the future by well and pipes. If a cistern was restored or re-plastered, it was from this time on done with modern cement. An important point here is that qadad completely fell out of use in the field area and none of the informants had seen it being used recently.

Today, the knowledge of using cement as plaster, or together with cut stones, is considered to be knowledge that exists in every village. However there are some people that have more knowledge than others about the best use of the cement and they are usually responsible for the important parts of the work: The plastering process, when the cement should not be too wet to avoid cracking later on, and for example, keeping the surface wet until it has hardened properly. Some cisterns restored in the 80's such as for instance the large main village cistern in Bani Hajjar (Mabyan), and one of the biggest cisterns in Qudam (Hajja), are said to have cracks and today in need of repair. This might indicate that the knowledge about correct mixture and application of the cement was not adequate at that time, and this is also commented upon by Stephan Krämer (2003). It could also be due to movements in the foundation, even if the sites of the cisterns are usually very old. When questioned about the cisterns newly built or restored, the informants always say that the cement is a good material without problems. This will be interesting to see twenty years from now, as the lifetime of the standing structure and the plastering is an important factor in the overall cost of a cistern and

hence, the presumed long term water price. That means that people must expect a certain duration of lifetime when they invest in a cistern and feel confident that the burden of new repairs will not come too soon. Of course, a sound foundation is just as important as the plastering to prevent cracking and leakage.

It is said to be commonly known today to use modern special additives and salts to the cement to make it easier to apply with less water. Earlier, cement that was too wet (to ease the applying) resulted in cracking when the cement dried (Krämer 2003).

According to Engineer al-Hadrami, one of the leading figures in restoration of historic buildings in Yemen, Qadad is totally without structural flexibility and non-elastic. This means that it cannot absorb any movement. Medium sized cracks are almost impossible to repair and once a cistern has developed a crack, the only way to really repair the damage is to recoat the whole cistern with another layer of the qadad.

Individuals in the qadad-maker group, on the other hand, emphasise that cracks can be repaired in a satisfactory way. The first argument can seem stronger as many old cisterns obviously have numerous layers as shown in fig. 29 and 30. But, if the foundation of the cistern is faulty or partly faulty, cracks will occur, often at the same spot, at certain long term intervals. By observing old cisterns, it looks like both ways have been tried, partly repairing the damaged area, but also a complete re-plastering from time to time. After all, some cisterns may be extremely old and further research on this topic might give a more exact answer. But undoubtedly is there an economic incentive to try to repair just the damaged area.

The qadad, or lime-sand mortar as Thomson (2005) writes about, is claimed to have a very special ability:

"Over time, lime-sand mortar develops a surface coating of calcium carbonate. This is formed initially, but also tends to build up, as calcium hydroxide saturated water is moved to the surface and carbonates. This surface, often referred as the patina and is almost marble-like, provides excellent resistance to water penetration, but allows for vapour penetration. Similarly, fine cracks that might developed are filled with a calcium hydroxide saturated solution, and carbonate, autogenous self healing the crack." (ibid:26)

If this is the case, qadad can have the advantage over cement to self heal finer cracks, even if it is true that it is rather non-flexible.

A future for qadad as local knowledge?

Today, experts restore structures for actors with money that want a “traditional result”. One price estimate given was circa 30 USD per m2 for a finished surface. This price is astronomically high compared to the price of using cement. A complete re-plastering of a medium sized cistern, (roughly diameter of 5m and depth of 4m) would be something like 20 sacks which is circa 120 USD. However, if the labour is not calculated, but only buying the nura itself, the price would be considerably lower than cement. It is the case of repair that is the most interesting case: Considering that there are so many old broken cisterns found in the field area, perhaps it would be possible to repair them more cheaply in a long term using qadad than cement? The cement adheres very badly to the old qadad in the first place which means that often the whole cistern has to be re-plastered, and if one was able to repair only the problem areas of the cistern with qadad rather than re-plastering the whole thing it might not have to be so expensive. The local knowledge of the actual qualities of qadad as a material in cisterns seems to be somewhat lost in the field area. As referred to in part 3.3 it is a type of knowledge that is also situated in the learning situation of apprenticeship. It is not as clear and apparent as the knowledge of erosion and water leading structures. Most locals do not seem to reflect at all about reintroducing qadad. The knowledge seems very much forgotten, but not yet completely.

Part 3

Social, cultural and economical possibilities and constraints in local water management

3.1 Introduction

When analysing the socio-cultural aspects of local water management, it is a challenge to choose the analytical units and concepts. The definition and classification of them is a theoretical act that oversimplifies reality to a large extent. Several different analytical concepts have been tried with varying success. The data about the socio-cultural aspects are not only of a more elusive character than those of a more practical nature in part two, but they are also less comprehensive. They are closer to assumptions on the scale of knowing nothing to complete certainty, and if the data were presented to different informants within the social system described, these informants would disagree on many details not only with me but also with each other.

Water management is a central part of local life in wider sense and delimiting this part of the thesis is thus far more difficult than in the previous parts. The traditional rainwater harvesting cisterns have been given the focus. They are connected through obvious causal connections to other forms of water management and indeed to wider economic and productional activity. Thus I will first describe the “core”, the management of the traditional village cisterns (part 3.2).

After that, I will follow some of the connections of this narrow aspect of water management to a more complex “modern water landscape picture” (part 3.3). These connections come partly outside the management units of the traditional cisterns and some of the actors are also partly external. This implies that an individual perspective also has to be introduced and some of the different social positions, statuses, relevant to local water management. Economic barriers and investment strategies are also treated. The Barthian model in the theory chapter will still be the main theoretical background setting.

The division between part 3.2 and 3.3 is a purely theoretical one. The first reason for the separation is to start presenting the management without too many complicating factors. Secondly, describing the traditional way of doing things with the implications of modern development is important at a time where there still are very obvious traces of the past. This "past", or traditional local rainwater harvesting cistern management, has through its techniques, but also through its management regime, put strong frames on today's local water management. The framework of possibilities and constraints from the past, through eco-technical, social and cultural factors, influences today's situation in a very strong manner. Trying to understand the situation today without the framework from the past is, in my view, not possible. Indeed, the "traditional past" is so close to the present, in all of Yemen, that men and women that are old today, grew up under eco-technical, social and cultural conditions that most people in our part of the world would never hesitate to characterize as "mediaeval". It is the sons (and daughters?) of this generation that are the main "managers" of today. Although the Yemenis seem highly pragmatic and innovative, old cultural symbols and notions of right and wrong cannot be changed overnight. Obviously, the eco-technical factors have changed, but the steep mountains, the rare but heavy rain, are factors that still have to be dealt with combined with extreme poverty in large parts of the population. The old way of managing water is still very much present.

3.2 Management of the traditional village rainwater harvesting cisterns

In his description of wider economic life in Jabal Marra, Barth (1967e) introduces "management units". He does not define these units exactly, but refers to them as theoretical units in analysis of social organisation within which management or circulation of values seems to take place. I will first present a generalized picture of management and then continue to point out some important varieties.

The informants really enjoyed taking about the "old days". Many of them were very proud of the past and what their forefathers had achieved, both in building the impressive infrastructure that still is very present today, and also the traditional knowledge, especially regarding agriculture, climate and irrigation. The chapter about the qadad was one such a "good tempered" topic and understanding was shown for me as a foreign person coming to them, wanting to record and study their "proud past". In many ways, the same was the case about rules and management regime.

Connecting different local narratives of the past and present management regimes, I could find some discrepancies, but in general they were quite coherent. It seemed that talking about legitimacy was not that difficult about something that had been dealt with in the past and that was not under discussion today. The topic was not perceived threatening to anyone's present day position or status. Although the management of the past is still in use today, few people criticize its legitimacy or authenticity. Perhaps the long time span of the way the water management has been performed has eliminated some of the conflict aspects, or that those conflict aspects that do have appeared, have become institutionalized. This is speculation, but my impression is that what came from the past was considered "just" and "righteous".

In local water management there are many management units. The traditional one, that to a large extent is still present, is the management of the cisterns in the village. The cisterns are common property to the village as a management unit. Actually, there were no obvious indications of this in the academic literature before going to the field, and I had quite

incorrectly presumed that cisterns probably were private because they appear small enough to be so. The fact that the cisterns are common property in the entire field area has some modifications, but they will be mentioned further below.

The locals' perception of history

In general, people do not count and keep track of years as a classification of time. Year of birth is often not known and the different political-historical epochs are not dated exactly.

Before circa 1850	"Before the Turks"
circa 1850-1918	"Time of the Turks" (The second Ottoman occupation of Yemen) (waqt al-éatrâk)
1918-1962	"Time of the Imam" (waqt al-éimâm)
1962	"The revolution" (al-thawra)
1962 until end of 60's	"The Civil War (waqt al-ḥarb al-éahlîya)
70's and 80's	"The time of cooperation" (waqt al-taôâwun)

When people speak about "The time of the Imam" (éahd al-éimâm, waqt al-éimâm), they mean the years after the Turks (1918), until the revolution in 1962, when Imam Yahya and his son Ahmad ruled the "Mutawakkil Kingdom". If something is referred to as older than the time of the Imam, it is called "time of the Turks" (-1918) and "before the Turks"

Farther back in time, the collective memory seems somewhat to end and two other categories appear. The first about the old history of Yemen, and teachers and local intellectuals have undoubtedly learned something about this from history books and the overall recent project of nation building. The other category is much more local and old, and is expressed as: "Himyari times" and "In the times of the first ones" (al-éawwalîn) meaning those who originally settled and lived in the area far before records that the tribal[28] people keep. Tribal people usually keep record of father, grandfather, and the descend group and if counting the given name, people have four names. Occasionally, more names in the genealogy are given and one informant quickly produced a seven parted chain of names, even though he was a young,

[28] (adj. qabîlî sing. qabîla pl. qubul)

tribal man living in the city. Although tribal people are not known to keep as long genealogies as the Sada (sayyid, sādā), some of the tribal families perceive themselves of higher rank than others and refer to a long known genealogy. For instance, tribal families that are not counted as Sada, but still specialized traditionally in Islamic studies, are called "Judges" (qāḍī, quḍāt). Several of the prominent Sada-families keep genealogies all the way back to the Prophet and distinguish between themselves according to which of the Prophet's descendants they descend from (Dresch 1989). These genealogies are not always absolute, but are negotiable and part of political life (Vom Bruck 2005).

The landscape is full of the past

Although this chapter will focus on the last fifty years, I will mention something about what people tell me of older times. These times are mainly mentioned when talking about old ruins of villages, forts, guard towers and even cisterns. The area is full of numerous historical ruins. Several entire villages have been abandoned, even long before the collective memory and many of the higher mountain tops have ruins of old fortifications, often with numerous cisterns and underground grain chambers.

These ruins are filled with myths, names and beliefs and they are usually said to be from "before the Turks". Again, people do not keep track of dates and years, but a certain ruin is often connected to a story of those who lived there and why it was abandoned. Always great admiration is always expressed by the size of the boulders used in the masonry and how strong the people must have been managing to lift them.

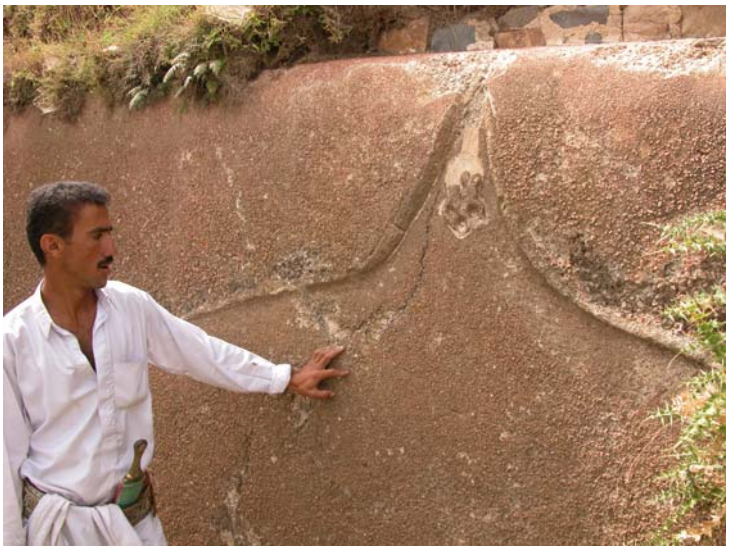

Fig. 31 A farmer shows me a very large rectangular old cistern with decorative details inside an old fortress on top of Jabal ôUlā. It was said to be abandoned even long before the time of the Turks. Note the thick soil cover over its edge indicating the high humidity at this altitude. Another indication of this is the presence of ferns.

Fig. 32 The entrance to an old underground grain chamber. Sorghum and millet are grain that store very well in sealed airtight containers and in old villages there may be many of these. The shape is like a bottle standing under ground hewn out of the rock. Today, they are often filled with debris as steel barrels are used instead. Dimensions are roughly 3m deep and 3m across. Traditional cisterns in the Madaba plain are made in exactly the same way (Wåhlin 1995). However, in the field area these structures are only for grain storage. One can observe the qadad is used as a mortar.

Analysing the paragraphs above as a background for the local view of the past, the water management that is narrated by the locals is, in my view, very coloured by how they perceived things were in the past and also a perception that the past they narrate was a "hard time", but inhabited by "strong and just" people.

Jural, moral and political aspects in local water management

Management can be said to be consisted of both a political factor incorporating conflict, negotiation and change, and a more "law-run management" where there are quite strict rules to be followed, and where there is little room for manipulating the rules and guidelines. Most management situations will probably contain both of these two factors. What a certain presentation of a water management regime will appear like, also depends on which of these focuses the researcher has, as most management regimes contain both elements of political game and at the same time definite rules and expectations according to local law. I argue that it is very important to search for both these ideal-types of management. Therefore, I will first present the formal law-like set of rules and guidelines, and after that, the more political and "flexible" ways people can manage the water. As mentioned earlier, Nicholas (1969) distinguishes between: *moral, jural and pragmatic rules*. I will try to discuss all of these rules as a framework of possibilities and constraints. However, first I will describe some important background information about social organisation:

Description of the social organisation of *management units*

Although focusing on the traditional rainwater harvesting cisterns in part 3.2, I want to include some other relevant modern aspects when describing the village. The description is thus not a projection backwards in time, but merely an exclusion of some of the present day connections between the traditional water rainwater harvesting cisterns management and other forms of water use. The description of different management units will start on small scale units moving toward larger scale and higher management unit levels.

The family

I will here describe a "typical" family. A man will marry at approximately 20 years of age however, more recently it is said that the money needed for a wedding is so great that the wedding has to be postponed some years. The married couple will usually stay in the same village and often in the same house as the man's parents. There are strong bonds between brothers, and they might own some of the family's land or property together, especially if the father is old and sick, but most property (mulk) is owned by an individual. Varisco (1982a) states that women can inherit and own land in nearby al-Ahjur, but a man is often needed to represent her in public matters. A married couple has on average between 6-8 children and before the oldest moves out, the household will consist of the couple, the children, and usually the man's parents, and perhaps an unmarried sister or brother. A typical household might thus consist of 10-15 individuals. The father will, when his son is perceived fitter than himself, somehow withdraw and stay more in the background in public matters and rather help with knowledge and advice. The elderly have much power through their knowledge and experience, but at the same time, the low wages old men earn in the money economy make them more reliant on sons that work outside the village for money. Caring for ones parents is considered an unquestionable duty and not obeying ones father is so shameful that the informants express that this is unthinkable.

Of the say 4 sons, one will stay in the village, one will move to Hajja city, and the two others to other cities in Yemen, preferably Sana'a. This is not a presentation of statistical datum but more like a model indicating that a family today is very often not connected to the village in the same way as before. Remittances from brothers outside the village are a necessary part of

the income in today's money economy. The other brothers will come home a few times a year depending on price and distance of travel, but most certainly every Ramadan. They will often come in the summer as the qat is cheaper and thus more weddings are held in the summer since qat is one of the main expenses for weddings. The late summer is also the busiest part of the agricultural cycle. It is not uncommon that the brother that "stays behind" in the village and is somewhat "subsidized" by the other brothers to take care of the parents, the land and represent the family in cases concerning the community in the village.

The village as a unit in the local water management

The village is not a homogenous unit. There are members that own private property and there are large differences in economical power. Sometimes new water infrastructure projects are carried out by the village as a whole but actually paid by almost one single beneficiary. The difference in economical power makes it a challenge to figure out how much different individuals or families should contribute to a common infrastructure project. I use the label *individual* or *family,* but the family is generally the lowest level of economical organisation in questions relating to agriculture and responsibility toward the village. A person might own individual terraces, tools, weapons and cars but he would still have very close economical ties with his brothers and male cousins and often the brothers manage some of their finances in common. The village as a management unit might give water to another village if necessary, thus making theoretical distinctions between individuals, families, villages, family groups (laqab), and even tribes can be misleading. These units may have very varying sizes, social functions and importance and sometimes the bonds cross cut the main patriarchical structure both vertically and horizontally. Ties with maternal relatives are usually not "public" but may be just as economically and politically important. Fredrik Barth treats the topic of cross cutting ties in his monography of the nomadic Basseri tribe in South Persia (1964f). Both he and also the anthropologist Peters (1990) maintain that such cross cutting ties are often of an unofficial character, but they stabilize the society and prevent splits in the main patriarchic system. Such bonds may also be of an economic character, for instance between patron and client or internally in the economic and political middle or elite level.

Each village usually has an elected representative, the *agil*, (ôÆqil, ôuqqÆl) that will speak for the village when dealing with local issues incorporating several villages. This position is

given to him mostly because of his personal character of being respectable and intelligent. The position thus is not that dependent on coming from a wealthy family, as being suitable for the job. He is the one that arranges labour for common infrastructure maintenance, and may function as an intermediary in minor disputes. In water issues he might deal with the yearly clean-out and minor repair of the common cisterns.

A typical village consists of 200-300 persons. Two or several dispersed hamlets might constitute a "village" as a management unit, but often the village is a single dense cluster of houses. The inhabitants will consist of circa 20 households. Since inter-marriage is common, the kinship relations can be very complex. The number of official inhabitants is also skewed by the fact many of the men that work and live most of their lives outside the village, but still appear in the statistics. When the villagers want to meet to discuss a certain common matter, a man from each household will come together, usually as a semi-formal qat chew. An important part of the expected role of the status "man" means to represent and defend his "weaker" members of his own family in a dignified way. This is done when the mature-aged man (not too old and not to young and un-experienced), or brothers together, represents their respective households.

If the case is a larger one, several men might want to unite, and this can be regarded as the lower beginning of a segmentary patriarchal organisation. This topic has been extensively covered in anthropologic literature about Yemen. However, there is so much diversity that making one single model of the tribal system will be an over simplification. The western escarpment zone is also more socially complex and less egalitarian than the highlands and eastern areas (Dresch 1989). The point here is that being a "man" and representing one's family, is the basis of the segmentary system of descent groups, sub tribes, tribes, and even tribal confederations. Being a part of this "system" and being an honourable man is the main virtue of being "a tribal" (qabiili). The virtue or "cluster of values" is called qaybala, and this term is the main topic of the PhD thesis of anthropologist Najwa Adra (1982). In Yemeni cities today, one may in certain urban groups be mocked because of the "backwardness" of rural tribal life, but at the same time, a "qabiili" is seen as a proud down-to-earth man that is honest, just and willing to fight for his cause. The tribal system has aspects of nationalism, ethnicity and even caste. The mazaayana is a group of tribes that traditionally performed barbering and butchering and still partly occupy this work. They are considered somehow lower than "real" tribal men that are always traditionally farmers. Below the mazayana are the

éAkhdam, that are of much darker skin tone and can still only have jobs as street cleaners. In much of the north western Yemen, the ratio between these groups mazayana - tribal - sada, is respectively 5% - 90% - 5% (Weir 1997).

Fig. 33 This picture is of al-Rakib, Hirba, a typical village in the middle range on the scale from a small low-land settlement to the fortified larger more powerful villages. This village has circa 200 inhabitants and the spring where water is fetched when cisterns are empty, is located far below at the bottom of the wadi some 200m down in altitude. The village has few private cisterns, although there are a couple of them. There is no road connection and no electricity. The land belonging to the village's inhabitants is not sufficient for food self sufficiency and work migration is a very important factor for income. The only cash crop is qat, but lack of investment capabilities has led to a prevalence of irrigation cisterns. On the mountain peak behind to the left, is the village of Jabal Sid. Land borders between villages usually follow the middle of the wadi. Thus farmers may own several different plots in very different altitudes.

The context of social organisation above is meant as a background setting for the following description of the cistern management. However, there will first be some pages explaining about the formal social structures that make clear and distinct frames of possibilities and constraints in today's local water management

Customary law (ôurf)

Local political life has in the field area throughout history been relatively little affected by state power. Exceptions have been at times during history when a state has made tax claims and claimed military support (Dresch 1989). In all other aspects, local life has been regulated through customary law. Customary law is a mix of a local jural practice of Islamic law and unwritten local rules and management principles that are considered just and legitimate. Seemingly, the customary law and other formal cultural frames as reinvented and invoked in the present through social interaction will be in accordance with the Barthian perspective in the theory chapter. The reinventing or, invoking, can of course not be done freely, but only within the existing ”room” for discourse.

All inhabitants are Muslims following the special school of Zaydism, a form of Shi’a sect that is endemic to Yemen. Only some tribes in Wadi Shiris and lower Mabyan follow the Shafi’ school, the rest of the field area is Zaydi and has been so for centuries. There is no significant theological difference between the two, except a major one being the Zaydi claim that the caliphate has been succeeded through the Prophet’s descendants and that the leader of the society, both politically and religiously, should be chosen from the prominent families of the Sada. In other parts of the Middle East they are known as Hashemites. This situation changed during the revolution and with the introduction of the republic, but is currently an issue.

Social status follows to a very high degree descent. So do the positions for the religious elites and families from the Sada that throughout centuries have claimed the positions in religious courts and the general intellectual, scholastic and bureaucratic positions available. In times of central state power, the Imâm, the religious and secular leader has come from some of the sada families. Some families from the tribal segment have also specialized in parts of this “high culture”. Men from these families are called qâdi and traditionally specialized in law. Today, state courts have taken over the function that some of these traditional elites had but local water management usually concerns such local issues, that in case of dispute, a form of local and traditional mediator is chosen.

The old courts were thus run by a clergical system that had ties with the rest of Yemen, and indeed the wider Islamic world. It can be discussed in detail what effects the “great tradition”

has had on legal water aspects. Maktari (1971) states that customary water law in Yemen is very localized and adapted to local conditions and the Islamic courts would use customary law and shari'a together without contradiction. Maktari's study of fatwa decisions, for example, states that unless there is a direct violation of Islamic principles, jurists in the past rarely objected to local customs of water management (Varisco 2000).

Both Islamic principles and Islamic law do imply some concept of "water socialism" in that water is a shared resource that cannot be owned per ce. At the same time it is obvious that this wider super structure of religion and law legitimizes private property including water structures. The requirement for sharing with the poor, for instance, is something that locally can only be observed done in rather extreme cases of poverty together with other types of general charity. Not being able to supply your family with water in the manner that is culturally expected is considered highly shameful among the locals. The same aspect of ethics versus pragmatism may be seen in hygiene issues. Several informants stated that religion demands people to be clean both physically and religiously, but also that the religion does give opportunities for people to act according to the circumstances. "You have to use what is made available to you by God."

The concept of jæyish, common work company, is used when maintaining the cisterns. Practically, this means that the cisterns are cleared of sand and silt when they are almost empty just before the new rain season. This is often organized by the ôæqil (elected village "foreman") or just spontaneously by the villagers themselves. It is considered shameful not to participate and thus there is a clear tendency toward a kind of economy based on shame and honour. Being known as someone who does not "stand up" for the community on an equal basis with the other villagers, is very degrading. If a person (a man as the head of his household) is not able to participate or find a substitute, for instance because of sickness or outside migrant work, money can be paid, either to use for similar village infrastructure needs or to pay someone else to do the work. Some informants say that the participation should be done at once, and that it is even worse if one accumulates a "moral debt" owing work to the community. Others say that if someone is prevented from participating in the jæyish, there is always an opportunity later to do some extra work, perhaps on another village project. Here, it is obvious that there is no "watertight" jæyish-sphere. Though at the same time, there is clearly

a concept of morality toward the village as a social unit and that the focus on “equality among men” is not freely exchangeable with money.

Ownership structures

Understanding ownership structures and customary law is a must for understanding local water management. By focusing on ownership structures, one may reveals social organisation and statuses relevant to the water management. Rights of use, usufruct rights and rights to land are fundamental ways of regulating and claiming resources and span between constant manipulation of micro-politics and almost self legitimizing absolute rights that are passed over by formal written contracts in connection with sale or inheritance.

Natural resource management is not performed by a single conform community as is often presumed. Still it is very common in the development sector to uncritically talk about “community participation”. The community is internally differentiated (Leach, Mearns and Scoones 1997).

The traditional common village cisterns are located on land common to the village. I already here want to give a presentation of local ownership structures as they are very old and well developed and the “system of ownership” is considered legitimate. Although conflict about ownership does of course occur, the structure of the system seems very solid.

It was beyond the scope of this study to actually map and analyse landholdings. Land and ownership in general is a topic that gives elusive answers. It is commented by several social scientists, that in general people are afraid that information will be used against them in future taxation or legal questions (Volle 1984; Tutwiler 1987).

In Hajja, and Yemen in general, the local concepts of ownership and rights have very old roots that legitimize and stabilize the perception of what should belong to whom. There is a “tool-kit of ownership structures” that is quite common all over Yemen and that also regulates much of the water management indirectly, by putting quite firm frames on the actor (Maktari 1971; Volle 1984; Messick 1992; Varisco 1997c; Donaldson 2000).

The role of written land holding records; a historical case from Mabyan

The following paragraphs about landholding records and their mentioning of water structures are relevant because the data is from the field area, but they also show how important and challenging historical studies may be when understanding management regimes with strong legitimacy from a long written tradition. The paragraphs below refer to a documentation of a long historical time span of rather unchanged ways of conceptualising ownership that has strong potential of legitimacy.

Elena Volle's (1984) article concerning land use and settling in Mabyan is one of the few studies from the Hajja area and is based on historical documents such as land holding contracts. She conducted a two months field study and planned to copy many of the land holding documents that are attested by an authority person or a religious judge, and also other types of registration of rights and duties upon juridical individuals. However, this proved to be very difficult as people are very reluctant to give away information about economic and ownership status to someone outside the community, and even the copying of documents was denied. This was among others things attributed to the fear of future taxation. Several of the western academic works from Yemen mention exactly the same phenomenon and also extend it to information of economic status in general. Almost by coincidence, she came across a large collection of papers in a mausoleum in al-Ðanqb in Mabyan, made for Imæm Salaç al-Dín b. Mohammad al-Washalí (1475-1504). She writes that there was a strong belief among the locals that any paper carrying the word Allah could not be thrown away, but should be stored in paper containers (ħaud al-éawrøq) in the mausoleum[29] . The result was a large amount of local historical sources that people were very interested in allowing research on as they themselves cared very much about their own local history.

The collection consisted mainly of Qurans including kúfí-style parchment volumes and other religious texts, but also numerous small pieces of paper stating land measurement, property rights and sharecropping conditions (leasing of land for payment in form of fraction-share of the crop). She photographed circa 300 of these texts.

[29] This sounds a little bit strange as even very mundane writings most often start with the basmala according to my observations.

Being in a messy state, badly preserved and often unclearly written in Yemeni Arabic, interpreting them was difficult. The material consisted of two main categories:

(1) Ownership documents, buyers' and sellers' contracts, and sharecropping contracts.
(2) Tax registers with many subgroups of information like local fatāwa (fatwa), private correspondence or notes on a major tribal war in the Mabyan area, and announcements of new waqf concerning definition of the donated "object", it's conditions and it's managers.

The frames of time of the material stretched from 14th to the early 19th century although most texts were from the turn of the 14th to the 15th century and from the mid 16th to the mid 17th century. She carefully points out that the style of the documents is surprisingly coherent over time and even stretches into today. Most of the stylistic features coincide with what Messick (1992) describes from Ibb in lower Yemen. He has an extremely detailed description about how these property right documents were written, and what role they played, and still play in society.

One of the most important points here is that after the usual introductory information and description of the property and the property's borders, the water structures are also listed and handed over together with the property itself:

"Die Auflistung der Grenzen wird in der Regel durch eine Formel abgeschlossen, die in etwa lautet: "Mit dem Kauf wird all da, was die vier Grenzen beinhalten und unfassen", erworben. Hieran kann sich eine Aufzälung dessen schliessen, was alles innerhalb der Grenzen vorhanden ist. Im Rahmen dieser auflistungen werden auch Brunnen und Bewässerungsanlagen genannt, über die durch den Vertrag verfügt wird." (Volle 1984:256 My underlining)

Volle does not mention more than this, but if assumed that the material is somehow representative in time and geographical area, this would be a strong indication that water structures (and rights) follow the land on which it is situated, and moreover, that this is an old traditional way of defining water rights with long historical roots.

The two last important points:

(1)There is a strong tendency that the land around Hajja is owned by local individuals during history[30] [31]. As Dresch and Gerholm describe (1984; 1989), in general, the western escarpment is a transition zone from individual ownership in the highlands and the east, and a much more feudal society in the west, where the land is much more fertile and population density is higher. Hajja is certainly in this transition zone.

(2)The place names are continuous throughout history in the Mabyan area: The study area reaches from Husn al-Ðafir [32] in the north to Shamsān in the south at the outskirts of the modern city of Hajja and including land in Wādī Sharas (Shiris) in the east.

These paragraphs above highlight the aspect that the long historical tradition of written ownership registers and records can act as strong legitimizing and stabilizing factors for today's local water management. "Legitimate" ownership tied to unmovable physical resource structures also puts strong frames on actors today. It adds an aspect of certainty to long term investment and that there are jural rules, as mentioned in the theoretical discussion, that actors can rely on, and expect not to be "circumvented" at any time, by pragmatic rules. The new phenomenon of private qat cisterns for instance, is actually understood as one of the few possible ways to invest in something that gives economic returns. This could not have been done if the actors were not completely sure that property rights were absolutely respected in the long term. In one way, one may see that the legitimacy that the old ownership right system gave and still gives, becomes a vital part of new phenomena such as the qat irrigation cisterns.

[30] Local does not necessarily mean "egalitarian".
[31] Volle also mentions one exception to this: Land possessions in Taiss and Zabid are mentioned in the sources. She suggests that this is because the greater Washalī family originates from there at an unknown point of time in history.
[32] A fortress city mentioned in sources from the middle ages and the seat of a famous 16th century Imam Sharafaddīn. The fortress was also held during a siege for one entire year during the civil war, according to informants.

Present land ownership structure in the field area

There are four main categories of land ownership in the study area:

1. State owned land (éArad al-Dawla)
2. Local common land (éArd mushtarak) (common to tribe, sub-tribe or village)
3. Private land (Mulk, éArd khass)
4. Waqf (pl. éAwqaf) (religious institution ownership)

These four categories are similar to the ones found in a study at neighbouring Kuhlan ôAffar (Bamatraf, Alsanabani and Aw-Hassan 2000). Under, the same categories have been commented upon with data from informants' statements, but also from written academic sources.

State owned land

There is no significant percentage of state owned agricultural land in the field area[33]. The state does, however, have a quite an important ownership role. The state is the owner of state infrastructure such as many of the streets and common areas in the city, main and secondary roads, schools and public waterworks.

The state seems to be perceived among the local informants as a "super-tribe" that now infiltrates into the original tribes' territory by force of confiscation, but also often by means of legitimizing through invoking that the interests of the state comprise common interests of the public (maslaha ôamma). The state has an influence on the water landscape especially through building of good quality roads on which water can cheaply be transported by truck. Making the state upgrade the road to one's village, is thus a topic that concerns people much. Roads are also often used as collection canals.

[33] There is some state owned agricultural land in western Yemen that was overtaken from the Imam. This land was confiscated from others in the time before the revolution in 1962 (Bamatraf et al. 2000). This type of land does not seem to be a relevant factor in the study area.

Local common land

Local common land is said to be owned by the tribe as a unit, but some informants claim that some areas also belong to villages. As stated earlier, the tribes seem in general to coincide with the lowest level of the government administration the *sub-district* (éUzla), although some sub-districts are made up of several tribes. All land that is not used for agriculture is considered common. Practically speaking, this means everything except terraces. Terraces are owned by individuals and the rest by the tribe or village. Roads and cisterns that are located on local common land also fall into this ownership category. The common land's primary function is pasture (marôØ or kilØé), and is said by the informants to be of the three things shared among Muslims: pasture, fire (wood) and water[34]. Some informants in ShirØqi said that parts of the pasture were private and that the common land had been divided in a minor land reform.

Another important function of non-agricultural land is the gathering of runoff. Often, a private cistern or terrace receives water from an area above that might be common property. This is called runoff rights and imposes rights onto common land and indicates that any development that can alter the runoff producing capability of the land can be denied by the downstream user. This is one of the main topics in Lichtenthäler's thesis from Sa'da (2003), where villages in the Sa'da basin, refused to allow the other villages to develop new deep well agriculture on the land they actually owned, because the owned land always had someone else's runoff right connected to it. The Sa'da basin is a slightly tilting alluvial plain with one shared groundwater aquifer. The situation changed drastically when a religious authority issued a decree (fatwa) that said that if the involved actors wanted a land reform, a process could be initiated where the upstream village got supreme ownership of the land surrounding the village if they gave up the runoff rights to the land around the village above. This happened in the 70's. This resulted in a major land reform process, not concerning the direct ownership, but rather removing discrepancy between runoff right and rights to land. Runoff areas were longer needed compared to the need for agricultural land that could now be irrigated from wells next to the fields. The whole driving force of this process was to be allowed to drill for water in ones own area near the village to make new irrigated fields that were previously only pasture

[34] One informant included roads, thus making it four, but he was not completely sure. Providing safety for travellers is certainly stated as a "tribal value".

and runoff harvesting area for the village below. One may say that the eco-technical frames changed which also led to change in social and cultural frames, but all within the old main cultural frames based upon jural rules and procedures.

Only rarely will someone completely deny someone else's development in one's own runoff area if the area is large as it often is for sayl (flood) irrigation. Practicalities do also play a role and if the runoff area is large and the actual development small, it is not considered a large problem. An economical compensation would be enough, if someone wanted to build a cistern. In general, most of these dilemmas can be solved with money or barter of land, but it is always emphasized by the informants that this depends on the climate of cooperation as well. This may vary greatly between actors and groups of actors. A water conflict often contains connections to other political conflicts. There are not always clear juridical distinctions but often hard politics of power, and avoiding conflict with potential future patrons is avoided at great cost. One's personal relationship to other actor is not separated from one's "professional" ties.

Private land (mulk)

As mentioned above, most agricultural land is private. Private land can be bought and sold or obtained through inheritance (wirth). The rules for inheritance are given by Islamic law and follow an advanced system of different fractions. The mathematics can become complicated if there are many parties involved as sons, daughters, brothers, half- brothers etc, all are entitled to different fractions. It is not uncommon that land is just kept within the brothers as a way of postponing the official act of inheritance. Money is needed if one of the brothers wants to buy the others out, and often he would have to work for a long time to be able to afford this. If the brothers did not buy each other out, the agricultural land will be split, and throughout generations the pieces of land can become very small and fragmented. To a certain degree, this is considered good and to own land in many different locations also spreads the risk of very local rainfall variability, and allows risk spreading concerning the types of crops that can be grown. Usually several different types of sorghum and millet are planted on different terraces according to local micro-climate and soil quality. Most families have some individuals that own spring irrigated land planted with coffee in the wadis. But, if the land becomes too fragmented, a land reform within the family is usually wanted. Runoff rights

usually follow its respective agricultural fields due to practical reasons. Inheritance is said to create much conflict within the larger families and memory of details a long time back in history is kept.

Fig. 34 Terraces in Shiraqq Shiraqq is a densely settled area south of Hajja city made up of four sub-districts and four tribes. The population density is 386 persons pr sq km (Maktab lil-éihsaq al-Jumhuriyya al-Yamaniyya muhafadhat Hajja 2005:128). The highest mountain in the background is Jabal ûUll. The terraces here seem to be more developed than in the lower areas and they are higher (2-5m high) and built more solidly. In the lower right one can observe the difference between pasture (public to the tribe) and agricultural terraces that all have individual names and are registered to individuals. If a terrace has a collection canal drains into the common land, the owner of the terrace will also own the water rights to the whole catchment area but not the land itself.

Waqf- land owned by God

Waqf is usually an agricultural field, a cistern or a roadside shelter (for travellers along the old roads), that has been donated by someone for the sake of the public. Such donations are said to give the donor religious merit (ûAjr). The property is managed by someone pointed out by the donor and this may be his own family. There will be certain guidelines for maintenance

and possible return of income. Mosques as institutions often have a large amount waqf land attached to them that provide them with money. The land is usually rented out in sharecropping arrangements. It is also called waqf when someone donates land or a cistern for common use for one family, a whole village or even a tribe. The phenomenon seems quite diverse in terms of private-public aspects and management guidelines, but waqf ownership types have the aspect in common that the land cannot officially be owned by one individual and cannot be inherited according to the Islamic law like land or water structures. Much of the waqf related to the villages is officially under control of the government that has a Ministry for Waqf and Religious Guidance. They do not, however perform any active management, and most of their agricultural land is rented out. Theoretically, waqf belongs to God.

As many village cisterns are old, the original builders are not known, but there are many cisterns that are said to be donated to the village by local individuals as waqf. On a wooden plate in the mosque in Jabal Sîd, the name of the donor and the year of construction (1077AH/1666AD) is mentioned. The cistern is very large, circa 900m3, and acts as a main cistern for the whole village.[35].

According to Bamatraf, 20-23% of the land in Kuhlân ôAffâr (neighbouring Shiris to the east) is waqf compared to 10-15 in the rest of Yemen. 75% is private and 2-5% state owned (Bamatraf et al. 2000:7)

In my opinion, it is somewhat strange that the ownership category of waqf is not more used in charity and development projects paid by outside sources. It is a way of placing charity into a local context. If “community participation” is to be performed without local cultural frames of “charity community ownership” it would be expected that what is donated could more easily be appropriated by individuals and privatised. As “religion” is an inseparable part of management practices and politics, development as common ownership cannot take place completely without involving religious discourse. Donations that are meant to be for the common welfare are, naturally, always sought captured by individuals and groups, but perhaps the waqf ownership is the one least subject to be captured “pragmatic rules”.

[35] After being struck by lightening it is leaking when more than half full. Lightening is indeed a danger when living on top of mountains.

Sharecropping (land tenure)

Sharecropping is common and simply means that the land is owned by one person and used by another for a certain fee. Usually the fee is a fixed fraction of the income which might be more on good land with water rights attached, but less on dry land farming. If a family has rented a certain field for a long time, they might claim that the field should only be rented out to them. Aw- Hassan points out that this rented land, be it waqf or sharecropping between private individuals, is less maintained than land that is used by the owner itself. This was seen in a study from neighbouring Kuçlan ôAffar where there was an increase in breaches per terrace (ibid). A tenant will have to manage the water rights that belong to the respective agricultural field, be it spring, sayl or supplementary rainwater harvesting irrigation.

Ownership of water

Ownership of water follows ownership of land in many ways, usually because the water structures are physically dependent on land to exist on per se. In Hajja, and in Yemen in general, there are two traditional principles from customary law for “owning” water:

If a dry watercourse is shared between users that tap into the watercourse at different heights, the upstream user has all the rights over any below him.

If the water source is characterized as a *ghayl* (ghuyûl), which means a spring, or any body of water that flows continuously, this is in most cases owned by the shareholders of a spring irrigation scheme as mentioned in part two. Water for domestic use might be taken from such springs by people living nearby, but only for the absolute needs. This is perhaps the most important water sharing aspect that is followed from the religious law. One has to be very poor to receive “water help” from other neighbours and it is discussable to what price in social and cultural capital.

Today, if the spring is located close to a road, the owners might sometimes do a small ownership reform, where some buy the others out, and then sell the water to tankers.

Owning rights to runoff from a certain area: As mentioned above, runoff rights and ownership to the land might be separate, but if a farmer wants to use runoff for filling a cistern or supplementary irrigation he would have to have the rights to do so, and if not, try to obtain them. Otherwise, the owners of the runoff producing land can give away the rights to someone else. Practically speaking, he would also need to own the land where the cistern is located.

Preventing land and water structures from being sold to outsiders

There is a moral principle in customary law that material values like land and obviously, water structures and rights, should be kept within the family and within the tribe. When something is announced for sale, other members of the group (family or tribe) on the respective level, have the right to buy, say the piece of land, for the same price as an outsider. It is considered highly shameful to sell anything to outsiders that will lower the overall position of the group.

I have now illustrated some aspects of jural water rules. I will now continue to focus on water related conflics.

When conflict arises

A wide range of conflict-settling opportunities are described by the informants. Going to a state court is avoided because of the cost and the corruption. Only in extreme cases is a legal matter concerning local water issues taken to court. In the old days, the Islamic courts and high ranking clerics would be sought, and the courts record of being just and incorrupt would be known by its reputation over time. In most local issues today in small scale water management, the two parties, usually two men, would chose an intermediary that both consider just. This can be any man, but usually one that has mediation as a speciality. It can be an ôaqil if the case is very small, but usually the shaykh of the tribe or sub district will try to get such cases and this way consolidate his role as a needed leader.

The two parties will agree on a deposit which value should correspond with the seriousness of the case. It is said that this used to be the janbiyya, that is, the dagger worn by all men in the tribal segment. The handle of the old daggers ought to be made of rhino-horn and the daggers are very expensive, especially if they are old hereditary pieces. Today, handing in one's Kalashnikov is more common. Money can be used, but few people have much cash or values that could easily be converted to cash. There is a strong symbolic component to this act; none of the weapons are usually used, but when handing them in, a man shows that he gives away his ability to fight for the cause and put the matter into the hands of the mediator's.

The gun is a strong symbol of not only the tribal male identity, or the previously mentioned concept of qaybala, but it is also about being "one among equals" in the tribe and being capable of representing ones family and "weaker ones"(Adra 1982).

The most obvious functional part of this custom is that if one of the parties does not accept the final verdict, he will not get his gun back. This is considered a highly shameful situation and is also the reason why finding a just mediator and judge is so important[36]. If one thinks the case is hard to win, or no values will be gained in the final compromise (sulh), one must either give in, or summon support from the patron (shaykh) and ones equals. If one's equals and the shaykh will not support you have a conflict line that is horizontal and between you and your community, and that is avoided at all costs.

The principle of using a symbolical and economical deposit to ensure that the final verdict will be respected, despite the change from the dagger to a modern weapon or money, can be seen as another case where continuity has aspects of change. Continuity and change cannot here be seen as oppositions, but rather as aspects of the same phenomenon.

Having knowledge about one's possibilities in this "game" is vital, and although being strong and independent is considered a virtue, seeking advice and going through ones options with close friends and relatives is necessary. Individuals that are skilled in solving problems, both as an "advocate" or as a "judge", will attain a higher rank than others, and reversely; no one wants to trust someone that is just born into the status of a "conflict solver". The same can be said about the status of the Øaqil as a representative of the village. Skill and knowledge about

[36] Often guns are bought according to what can be afforded. The economical side is considerable.

local social and cultural facts is needed and used in what Nicholas (1969) calls pragmatic rules. Local knowledge about the informants' own society is often limited knowledge that is valuable because of its relative scarcity. If everyone knew everything what about was going on in local politics, the statuses mentioned above would lose much of their power.

During fieldwork, I tried to focus on getting data about a concrete ongoing conflict. However, it was difficult to make people talk about conflict issues, especially in very small communities. My status during many of the interviews and conversations was clearly one of a guest's, and I also felt shy to pressure people to talk about conflicts. Methodologically, this could have been different, if I had stayed for a long time in one place and thus gotten information from one of the parties by obtaining more trust. This actually did happen several times during fieldwork, but never during the visits to the villages outside the city.

3.3 Aspects of modern change in local water management

This chapter will focus on the immense changes that have taken place during the last fifty years in the field area. The focus will be on technology, social organisation and culture.
The area has become more closely connected to the rest of Yemen that has in turn, to a large degree consolidated into one state, and also with strong ties to the wider region and the wider world. Intellectuals and elderly people often stress that during World War II Yemen was completely self sufficient and people did not feel much affected by it. One old man said:

”During the time of the Imam, people relied entirely on the local land and perhaps a few things from the local market, even during the Second World War. The only thing that was imported was needles.”

These words should perhaps not be taken literally, however, before the revolution there was rather little contact with the outside world and the subsistence economy dominated. Coffee and other cash crops in spring irrigation schemes were produced even in the past, and the field area was not completely economically isolated in the past. The role of local cash crop economy in pre-revolutionary times is an important topic, but will not be given much focus here.

The topic of politically powerful mountain shaykhs owning farmland in the distant major wadis and lowlands, has made parts of the traditional economy not only geographically local Further more, it is important to recognise that tax collection, powerful landlords and regional trade have played an important role throughout history. (Dresch 1989; Meissner 1997)

Conceptualising the field area’s recent increasing integration into the “global world”

I will here to mention the geographer Arild Holt-Jensen’s (1999) concepts of *vertical and horizontal* place *connections*. He mentions that often in modern history, one can see how a certain place has moved from being almost self sufficient into being completely dependent on the global economy. He explains this by focusing on the connections between the place and the local resources and he calls them *vertical,* and outside connections of trade, economy and

outside civilisation-impact are called *horizontal*. By using a geographer's perspective as one imagines to view the world from above, like a map, the places' connections to their own local resources can be seen as vertical. It also offers a framework for a perspective of the process of "globalisation". Geographers usually focus on the present, but the same phenomena can also be seen in a historical perspective:

Undoubtedly, the present integration aspect of globalisation can revert the other way as well, as LaBianca (1990) illustrates how *sedentarization and nomadization* characterize the food system and human adaptation throughout history in the area that is present day Jordan. The local society is a combination of a "great tradition" and a "little tradition" at the same time. The great tradition is represented by the political elites, city societies and scrip-based culture that, sometimes during history have mixed with distant local communities as well. At times, civilisations have faded away and the locals have fallen back on more self reliance socially and culturally, but also technically related to decentralised water supply such as cisterns.

Culturally, globalization might even produce even more "localized" culture as presented in the book edited by the anthropologist Eriksen (2003). However, when focusing on local production and economy and not culture, the recent local integration into the world economy has certainly put new frames onto the local water management. Focusing on food, for instance, as dealt with further below, there have been fundamental changes in peoples' everyday life.

The reason for connecting the *vertical and horizontal connections* with *great and little traditions* is that the latter emphasises more the cultural and social processes in addition to productional and economical connections.

A topic like religion from the field area illustrates that despite the enormous changes in the society in Hajja during the latest fifty years, the "connections" regarding religion have always been, to a certain degree, horizontal, and have had aspects of "great tradition". This points to focusing at these theoretical concepts as neither vertical nor horizontal, but as a model that allows to us think that a "local" society (what many geographers will call "place") has connections to the outside space and time of varying qualities; economic-technological, social and cultural, and that all these connections vary in time.

The end of the civil war (1962-1970) was an important turning point for the area. During the war itself, most of the countryside around Hajja supported the old regime, the Imam. Hajja city was most of the time a small republican island. The republicans got substantial support from Egypt and throughout the period and the royalists were backed by, among others, the Saudis. The war and hunger took many lives. When the republicans won and took over, everyone was looking forward to a better future. For the field area, the transition from being isolated in the "Middle Ages" to watching films on television and buying consumer goods was extremely short. Within 10-15 years, a significant percentage of the villages had gotten road connections although homemade and rough, and the men worked across the border in Saudi Arabia and sent home money. Much of this money was used in common infrastructure projects such as schools, water projects and roads. This was not only the case for Hajja, but also for much of the rest of Yemen (Dresch 2000). For example, the first public waterworks in Hajja City was paid by the local inhabitants of the city (Carapico 1984). Indeed, the informants themselves often refer to this period of time as "the time of cooperation". "In those days, there was money for common local development projects". Many of these projects were small scale and completely without administration or interference from the state. Some projects were larger, for instance the road all the way from Bani al-ôAwwam through the rough mountains of Shiraq (Swanson 1981). Special laws at this time allowed local authorities to collect the tax, the religious tithe, Zakat, directly, without government interference (Carapico 1998).

The 70's and 80's were prosperous days of rapid development as many of the migrant workers sent substantial amounts of remittances home, especially from Saudi Arabia. The percentage of migrant workers leaving for Saudi Arabia was especially high in Hajja (Kopp 1981). This could have had several reasons:

- The proximity: Hajja borders Saudi Arabia with a good road connection along the Tihama coastal plain.
- Modern development in the area was very sparse. There were no factories and a relatively low construction activity that could give employment outside the subsistence agriculture.
- The previous civil war had been extremely hard in some of the areas in Hajja (Schmidt 1968; O'Ballance 1971). Leaving was the only solution for many when the first opportunities came.

The 70's are often called "the time of cooperation". Men sending money home allowed local councils and local communities to carry out projects that the state was not at all capable of at that stage. An important aspect in this respect is the beginning of car road building. Schools were also built with local money, but talking with informants about infrastructure related to water, they always point out to me that the first roads were built by themselves with their own money. When the migrant workers first came home for holidays, they would have to carry all the new stuff such as generators, TVs and freezers up to their villages.

There were no car roads in the area at all. The Imam made a road from Tihama to Hajja and from Hajja to Amran and Sana'a, but this track was not able to accommodate modern cars. In the 70's, Hajja got its roads repaired and new feeder tracks appeared quickly. "These first roads were built by crazy ones", one informant pointed out. "They were so steep, rough and hard to use that some of them later got abandoned". For instance, at Jabal Sid, the road was never repaired after a rainstorm that destroyed the lower part 20 years ago. Before that event, they had more than 30 cars in that village alone. The cars in the field area were all Toyota pickups, four wheel drive. Many of these cars are amazingly still in use. With a skilled driver they can "climb" up incredibly rough roads. The comprehensive local knowledge and culture concerning the use and maintenance of these cars in the demanding landscape is an excellent example of how quickly local knowledge can emerge.

Some villages were fortunate to be located along the road that other villages needed to get to Hajja city and the main road system, and thus got an earlier and cheap connection. Villages located farther away, later had to buy themselves into some of these roads in order to get access. Distant lying villages that were located in such a way, that they were the only ones needing the connection, had to struggle very hard to get enough money, and even today there are several villages without a road connection. Roads were often built along old riding and walking paths if the topography allowed it. This solved some of the problems of agreeing of where to lay the road, and who should give up land. Other feeder tracks that are more important connecting several areas with the main road system have later gradually been overtaken by the government and partly improved. Heavy rain and rock-fall still cut the roads to thousands of people on a yearly basis.

The prosperous days of the 70's and 80's, ended abruptly at the beginning of the first Gulf War, when Yemen took a stand in the UN Security Council against involvement of the

western world. Within weeks all Yemeni migrant workers were expelled from Saudi Arabia[37]. When the migrant workers had returned home, the population had increased and traditional subsistence farming did not at all cover the need. After that time, large segments of the population got significantly less income. The money flow, that earlier made its way to local shopkeepers and even day-labourers stopped. Thus the local side of economic activity fell drastically.

There have been major changes in the food consumption since the revolution. These changes have mainly to do with the general globalization of the economy. Food was no longer a limiting factor in society as it traditionally could be in climatic periods of low rainfall. The population has quadrupled since that time and ¾ of the food today is imported. Traditional agriculture is important in the countryside where ¾ of the population still live, but even here, life is not possible without imported food. Thus, looking at the increasing *horizontal connections* (Holt-Jensen 1999) and the integration into the world economy, it is easy to see that food availability, through economical means, has laid a foundation for an increase in population that has reduced the available local water resources significantly. This does not mean that population increase is solely due to increased availability, but in the past, food availability certainly was a strong delimiting factor in periods. Perhaps population increase is the largest factor that has put constraints on the local water supply in terms of quantity.

The paragraph above introduces some important background information. The water management seen today did evolve for several hundred years and remained somewhat stable. However, the onset of modernity came with the fall of the Mutawakkilite Kingdom, represented by the Imam and the end of the isolationistic policies made field area integrate into a national, and world wide economy to a much larger extent than before.

[37] At that time Saudi Arabia was probably looking for an excuse for this because of the rising unemployment and other internal problems.

Fig. 35. North east side of Jabal ôUlá just below the summit at circa 2200 masl. The higher mountains of Shiraqá are quite green during the wet summer. The pasture areas are common land that are kept mahjúr, that is "protected" from grazing animals during the growth season in order to not damage the pasture and to make sure that there will be enough fodder to be collected and carried home for the dry winter. It is the women's job to gather fodder on these steep slopes. This, and herding in this steep landscape is dangerous. The terraces seen on the picture are the upper half of a large set of newly restored terraces after having being totally abandoned for many years. Two farmers from a village on top of the mountain used four years to complete this work. Only qat seems to give enough returns to start such work. On top of the mountain there are several restored cisterns and by using hoses, the qat field can be effectively irrigated. There are also impressing ruins or a large fort at the mountain said by the locals to be from "before the Turks". The blue canvas keeps stored stalk for fodder dry. Note the many patches of terrain covering grass that can only be found at this high altitude where the winter is cold and foggy.

This transition into modernity greatly affected social and cultural processes of the field area and new technologies became available and taken into use. The eco-technical frames can be said to have changed as a consequence of these changes. As I will refer to later, the feedback loops of the Barthian model also allow us to expect that the new eco-technical frames also have affected the rest of the local water management. The new private cisterns that some individuals have made for irrigating qat for economical production, is perhaps the main example, but also the tensions between the old moral economy of shared domestic water and today's tendency toward commodification. I will also to put forward some of the main factors in the process of change:

1 Roads and cars
2 Labour migrations
3 Import of food and consumer goods import
4 The state's gradual appearance as an indirect actor in local management.[38]

Who among the local actors that have gained relative power during this transition, is somewhat unclear. Obviously, many of the old land owners and shaykhs have exploited their positions and have thus obtained far more from the government than poorer ones, but no doubt, there was also many of the old elite that did not advance much.

The four main factors mentioned above are connected in many ways, but especially related to local water management, I will argue that further analysis will benefit from an economical perspective. I here mean *economic* in a broad sense, and will keep the analysis open for other values as Barth does in his perspective on circulation of values.

First, I will give some introductory reflections regarding the role of the state. This information does not come from one specific source, but has become clearer throughout the research process. The informants' opinions are the foundation, but my own interpretation is presented as well.

[38] In my opinion, other expert knowledge and economical support from developmental NGOs have never challenged the role of the state or its rulers.

The role of the state in local water management

Calling the state *state,* is in my opinion a highly unfortunate mixing of a local category and a social scientific term. Comparing *states* as large units in social systems is a difficult theoretical task. Without going into definitions of *state,* I must strongly emphasize that it should not be confused with the average state in our parts of the world. Lewellen (1983) categorizes the state as a centralized political system. He also points to the fact that states compared synchronically and diachronically can be very different. Below, the term state is used more in the emic sense of the term.

The locals seem to look at the State (al-Dawla) or the Government (al-Hukûma) as a "super-tribe", as mentioned before, that represent strong outside forces. It is a provider of benefits but, also demands political submission. The benefits mentioned by the informants are usually political stability, law and order, and that once in a while the state donates some pieces of infrastructure to those districts that have not been opposing the government in the recent past. However, by far the largest benefit is that the state is a provider of paid positions. Most locals will have a close relative employed either in the army or in civil service, often as a teacher. Positions are usually inherited, especially higher up in the system of administration. Wages are low, circa 120USD a month as a fulltime teacher or soldier, but showing up is often enough. I heard about one person having four positions (!). It was said that he was an extraordinary clever and diligent man. Stories of paying a fixed amount of your salary to your superior is not uncommon to make sure your superior will not require you to be at work all the time. In the study area these paid positions that the state provides also demand, indirectly, a semi-political support of the legitimacy of the state. This does not necessarily imply support for the ruling party, but criticism of particular policies or persons is not accepted. The state may thus be seen as a super patron or system of patrons while the lower employees are clients. However, some informants emphasize toward me as a "recorder of reality" that the state is democratic and legitimate. Calling a spade a spade is in many ways not beneficial, be it for locals, development actors or local and foreign scientists. Much of the management on the state level is hidden from the locals and it is considered completely normal "not knowing", or even take part in, general decision making.

The state is also a provider of symbols for the national Yemeni identity and this is in the field area done much of the time through schools. Education is highly characterized by learning by heart and learning not to challenge the structures of power. Illiteracy is high and from the rural field area very few continue on to high school.

The state is known to not be very considerate to weak parts, for instance, if previous runoff is cut off, and the downstream cistern or field becomes dry. Much of the foreign development and economical resources in the field area are invested through the state's legitimacy, and therefore it is a significant actor. Much of the field area outside the Hajja city is not "state landscape" at all, except some few stretches of road, schools and a couple of public waterworks. Although not being a significant landowner, the state does create zones of ownership claims around its infrastructure. The local elites, even in rural areas, are offered positions in the state administration and in this indirect way, the locals cannot protest against the state through their tribal shaykhs as these are in a conflict of loyalty. The conceptual limits between the state's and locals' water management are thus very complex.

The whole issue of "nepotism" and "corruption" is one of local knowledge. It is about "pragmatic rules" of how "laws can legitimately be circumvented", as formulated by Nicholas (1969). By using the terms *corruption* and *nepotism,* the analysis can quickly lead to a kind of morality that makes both the analysis and the conclusions difficult to use. Looking at *social capital* and *reciprocity relations* may be more beneficial as these terms are not used in prejudging way. It is important to bear in mind that economical insurance does not exist in the field area as is common in the developed world. Banks are not secure when looking at long term inflation rates. Public social insurance does not exist and adequate education and health care is not available for free. All these aspects make social ties, especially between family members important, far beyond the importance of family ties in, for instance, Norway. The same can also be seen in many other social relations for instance between an influential person and his followers.

What is defined as "corruption," depends on the degree of bureaucratization of the social landscape. It is my impression that the locals do have standards for "just treatment", but nurturing the ties between client and patron is considered legitimate, even in "public life".

This could perhaps be a good example of how difficult it would be to use the Barthian model without knowing the complexity and the character of state as part of the social factors. Being critical to one's own analytical categories is possible in qualitative studies and finding out such things after several times of testing. By using Barth's process oriented perspective several times in combination with my data, I could after some time understand that the state is not necessarily the same as the state in other societies. This might seem trivial, but it actually is a good example of how theories can be used as tools during the entire qualitative process, and not only to explain and highlight the data after the research. The use of theory is an ongoing process in all phases of the research.

In parts of the field area the state has provided, some informants say "given", public waterworks to the people. These are run by different government committees sometimes with a local component. The World Bank also has several medium sized public waterworks in the more rural areas. Most locals do however, feel that they have little influence on these projects and the politics around them are for "important people", "the responsible ones" (al-masé'ûlîn)

The anthropologist Sheila Carapico has written a book about "Civil society in Yemen: the political economy of activism in modern Arabia" where she discusses the development of *civil society* at a time when the state was even weaker than today. She highlights the differences between civil, meaning primordial, tribal, and on the other side the appearance of non governmental interest groups that cross cut the entire society. In Yemen, as mentioned above, as also found in the field area, much of the infrastructure and management was done without the state. However, personally, I find it difficult to classify the forces behind these actions within the field area as *civil society*.

In Yemen the "primordial" groups are still very much present based on the patriarchal ideology of a man's belonging to a tribe together with equals in tribes combined with a different overlapping complex system of patron and client where position in government and person in not clearly separated. These two "models", combined with an authoritative state, in my opinion, effectively prevent the growth of what in Norway would be called "civil society". I will argue that, despite meagre data, the "action groups" and local development

organisations that do exist in the field area[39] cannot be expected not to follow the "pragmatic rules" of the social and cultural environment they operate within, and by which their members are also obligated members of.

There is severe danger in that those forming development aid and foreign policies cannot sufficiently see that a "civil society" as known, in for instance Norway, cannot at all be expected to emerge under present conditions. Problems related to water in the field area are closely connected to poverty, ignorance and governmental priorities and cannot, of course, be separated analytically from either "state" or "civil society".

Aspects of regional integration

The other factors regarding the modernisation process beside the state as mentioned above are: (1) the roads and cars, (2) labour migration and (3) food and consumer goods import. The first of these, the appearance of the roads and cars is a topic that is related to labour migration. However, the roads also opened up the national qat marked, and although Hajja does not export as much qat as the mountains of al-Mahabisha to the north with its famous "shami-qat", the roads have also been important for the internal qat marked in Hajja. Finally, directly relevant to water management is the connection between the roads and water transport.
Water can now be transported from where it is available to where it is needed. The cost comes mainly from the transport itself as there seems to be enough water to feed the truck demand from local springs and from shallow wells in the flood bed of Wadi Shiris next to the main road. Indeed water is even transported out of the field area by truck up along the tarmac road toward Kuhlan ôAffar, all the way up to the zone where qat cannot be grown due to frost at about 2500 masl.

Deep drilled wells seem not to be preferred in the field area as they are in the coastal plain zone and the highland plateau zone. It is expected that both due to the high topographical

[39] In the book Muhafadhat Hajja 15 ôaman – min ôatéat al-wihda al-mubaraka min 90 hatta 2005 by the Central Statistical Organisation, 38 different NGOs are officially registered in the Hajja governorate, of which about 10 are involved in charity and local development according to their title. (Maktab lil-élhsaé al-Jumhuriyya al-Yamaniyya 2005). Which organisations are listed or not, and what they do is arguably uncertain. Some of them are known to receive money for small development projects of charitable character.

relief and the presence of hard Precambrian bedrock, rainwater harvesting is preferred to ground water drilling. The water trucks can, however, connect all water sources into one single water market where the only barriers are bad road connections. Private rainwater harvesting in cisterns is an economic strategy that is widely preferred over reliance on buying water from trucks. Again, there are obvious cases of isolated villages with a very rough road, but even in areas with good road connections, cisterns are built. Here, many factors could be mentioned; to have water stored in a cistern seems to be culturally valued. Water is considered aesthetic and stored water also represents wealth. However, looking at strategic investment possibilities combined with cultural notions of self-sufficiency, rainwater harvesting cisterns seem to be one of the locally preferred ways of investing in one's home village.

Water in the wider (economical) production

It is repeatedly mentioned by the informants, that qat is the only viable agricultural cash crop strategy unless you own a small piece of land that cannot be enlarged with large amounts of water connected to it. This may be the case in traditional spring schemes and in wadi sayl irrigation. Above 1200 masl, under which altitude qat does not grow well, mango and coffee may also grow, but value production per litre of irrigation water is far better in qat production. Barth states about land use in Jabal Marra in Sudan, that "the amount of land and labour allocated to cash crops reflects the population's felt need for cash goods." (Barth 1967e:85) If this is the case, it is easy to state that limitation of water limits people's ability to reallocate land for cash crops.

Sharing the common water in the village cisterns

The further analysis is aptly demonstrated by a question I asked: "since you have cisterns located above your village and they are considered clean why don't you put a hose or install a pipe from them down to a common tap in the village to reduce the workload?" the answer I received was very informative. He looked at me and said as if the answer was very obvious:

"In that case the inhabitants would use too much water. We do actually do that sometimes, but only during weddings. Then we have a hose running with water. Fetching and transporting the water from those cisterns is not considered a heavy workload. The women are used to fetch water from cisterns located much farther away than this, and even down in the wadi spending two hours going and returning. Those cisterns above the village are considered close. There is no need for reducing the workload."

During weddings very many guests arrive and water consumption is at a peak. More water is needed not only in the households, but also for the guests for drinking, washing and the religious cleansing (wuḍūʾ). However, the cisterns were located 50-300 m away in difficult terrain and certainly much effort is used getting the water down to the village in my eyes.

This answer illustrates that the idea of using gravity fed hoses as transportation technique is actually used the times it is considered beneficial, but not in usual operation of the "system" since it would remove one of the most important incentives for using less water, that is the economical individual cost of transport. Other incentives, such as common surveillance, and "shame and honour", might be other important ways of controlling each others extraction.

Why is there then no alternative way of sharing the water quantity, if a hose or a pipe was used for transporting the water? Sharing of water is a very common thing whenever there is a spring watering agricultural fields. In the wider area, a wide array of traditional ways to measure and share water is documented (Varisco 1982a). Of course there are differences from irrigation water measuring and sharing compared to a new situation with a tap with water for domestic use, but using a system of sharing according to quantity could be possible just using a bucket as a "meter". However, that would imply that today's more flexible system would have to be abandoned. Today, a family can use more or less water, (probably within certain limits) if they can manage the cost of transport. This would also depend on other ways the village can restrict the individual's or family's water extraction. The economical "built in" cost added to the water quantity by fetching and transportation, might be combined with other measures such as "shame and honour" and common surveillance. Today's system is, anyway, considered "fair" by the informants.

Economic spheres

Water for domestic use and for irrigation sometimes comes from the same source or technology such as the cistern, water truck or piped network. However there seems to be a *tendency* toward economical spheres between the money economy and certain forms of circulation and production related to women's work and local intra village reciprocity in the field of water. Using Barth's (1994d) concept of flow of values within spheres certain patterns become clear:

The women's work in local water management is the most clear example to be presented in view of the sphere theory:
(1) There is no work for women in the villages that is paid by money.
(2) A substantial amount of water related work is actually done by the women, if not most. Only in irrigation issues do the men carry out the work.

Women never do any work for money in the villages. This is considered highly immoral. It is a woman's responsibility to carry water from the point of source to the home and also in all the processes of domestic water consumption and use. The carrying of water takes hours and is the main "value" or "cost" in this system. Women may help each other out reciprocally but a man can never hire someone else's woman to fetch water. Moreover, the woman's work in water issues or any other domestic work tasks is never seen reflected in money. It is never compared to money. While men try to calculate amounts of water for different prices, its timing for irrigation, if they should rent a water truck the coming evening or not, the women's work of water carrying is never used in irrigation.

By following the physical water one can observe that water never crosses the two spheres unless there is a temporary water crisis and some collective action is taken to buy or transport water to the village from a non-ordinary source. Women receive money from their husbands to buy items from the shop or market, but usually this is done by the man himself or by the children. The man is officially considered as the only manager of the household money, however, as I could never access the women's realm, I can not say if and how this is contested or resisted. Thus as a man's water activities may involve money, women's do not.

Irrigation and money vs. domestic water and women's work

We might observe a barrier in the "rational economical life" between two different economic spheres where values in one of them are not compatible with the other.

Water for domestic use is the women's daily responsibility and they often spend enormous amounts of time fetching water from distant cisterns and springs. Often informants say that toward the end of the dry season the women have to fetch water from the wadis often 300m down and several kilometres away. 20 litres is carried on the head and a donkey carries 2 times 20 litres. This trip often takes 0.5-3 hours and may have to be done up to three times a day. This significant workload might not be considered as useful to convert to other "values" in other ways or other jobs. It does not cost money and it does not produce money. The same seems to apply for the gathering of wood for cooking, and fodder grass for the animals, which is also the job of women. This is expected of women as a way of contributing to the family economy, but it has nothing to do with money. There are no jobs that give money outside the home and it might probably not be considered appropriate if it existed. Women's labour does not "cost" anything. As one informant said:

"It is just what a woman is expected to do".

The workload for women would be expected to be lower in areas where road coverage is good and hence the price of truck water is cheaper. It is mainly in poorer families and in areas of difficult road access that this barrier between the spheres seems to be strongest. Buying water for domestic use by truck would save enormous amounts of work and make time available for other activities. However, spending money on reducing the workload of women seems to be irrational in the local men's eyes. Investing in cash crop infrastructure is obviously considered rational. So what is it that creates this barrier between the money-irrigation sphere and domestic water-sphere? It might be the functional reason that women's work cannot be converted to money, but this is just as cultural as it is functional; it is a cultural norm that prevents women from earning money, not an eco-technical "fact". If they have to get water, firewood and fodder grass and in addition wash clothes, make food and take care of the domestic animals, the average 7 children *and* the parents in law, who would have time to earn money in the first place? The concept of "Spheres of exchange" (Parry 1989) then seems rather theoretical. It is crucial to bear in mind that an observed pattern of action does not need

to have an underlying "scientific law", but rather that there is a complicated set of contingencies both practical and cultural that produce these patterns.

The anthropologist Gunnar Håland treats a very similar topic in his article "Beer and mothers milk: Symbol, morality and choice in the Fur society"[40](1990). By using his way of analysing, the women's contribution to the household in form of water may be seen as an exchange where the man, on the other side, has to contribute with staple food. Håland also theoretically divides the *system of symbols and meaning* from the *system of interaction*. Although, different terms, I take this to be consistent with the division between the *social and cultural framework of possibilities and constraints* as used in this thesis. One of his main points is that the cultural role expectations of how, in this case, a woman should behave, are negotiable and not absolute. In the meeting of other cultures or sub cultures these role expectations can change. Håland also mentions that the cultural frames sometimes have to change when confronted with "objective forces" such as other people's opinions and actions. Social interaction produces *externalities* that change the situation of available choices. This is what Nicholas (1969) calls "Technical facts" and "Regularities" as mentioned in the theory chapter.

Since the water in the cisterns is commonly owned, it seems to make the inhabitants reluctant to construct facilities that ease fetching and transportation of the water. The fetching and transport add a cost to the water use of the individual. Other costs are shared on village level and the individual cost of fetching, and mainly transport, is the only direct economical factor that limits water extraction from the common cisterns. This implies that as a shareholder you feel better off, if you know your neighbour has to "pay" for the water in terms of work load, otherwise he (she) would use more than his share.

[40] The article is in Norwegian and the title is "Øl og morsmelk: Symbol, moral og valg i Fur-samfunnet" and is listed in the bibliography accordingly.

3.4 Local knowledge as framework of possibilities and constraints in the water management

It has not been my intention to "map" all the local knowledge concerning the use of the cisterns, as this task would have been far too extensive. It is also somewhat questionable if local knowledge can be "recorded" without losing major aspects as the knowledge is so embedded in different scales of eco-technical, social and cultural factors. However, I have chosen to focus on some different types of knowledge as a small case study to highlight some of the very different qualities these different types of local knowledge have and how they are reproduced in relation to the framework represented by the Barthian model. The cases are chosen and delimited only for the sake of highlighting their internal differences, however, this delimitation is probably not justifiable for representing any comprehensive picture of the knowledge that is present in the field area.

The different main cases are:
1. Practical knowledge: The canal detail *ôdgala*
2. Local knowledge of water quality and quantity

The ôdgala[41]

The collection canals (as described in part two) are not at all spectacular and often hardly visible unless you are looking for them and know what they look like. The canal is dug into the ground or consists of a ridge built laterally along the slope (or both) and it will capture small incidents of runoff somewhat like a gutter on a roof. The canal can be constructed in many different ways. The inclination of the canal must be at a specific angle if the canal is not hewn into hard rock, otherwise, the speed of the water would either erode or deposit

[41] The correct transliteration is by using qdf instead of "g", however since it is recorded as a spoken word it here given as close to pronunciation as possible. There are unfortunately no good pictures of this detail. One can be observed in fig 19 in the collection canal.

sediments in the canal. Both cases would lead to destruction, possibly already during the first rain shower.

Sometimes, the water has to be conveyed down the mountainside at an angle steeper than the optimal inclination regarding erosion. The solution to this is to build a small pile or dam of rocks in the canal known as an ôÇgala. Behind the rocks, the water will rise when the rainfall causes a small flood to come, since most of the flood water cannot pass through the stones. Here, in the long narrow lake that is formed, sand will be deposited until it almost touches the water surface. At that point, the current starts to carry away any more sand coming in and washes it over the rocks and downwards. The point here is that the pile of rocks takes out the speed and energy of the water in one place, instead of eroding the entire length of the canal floor and walls. The sand is always a part of the water flow and has to be given free passage as well as the water and thus has to be part of the "calculations" behind the technical side of water management. This also implies that nowhere can the water flow so slowly, that sand would build up, and the water spill over the edge of the collection canal. The ôÇgala acts as dam for the sand and when the collection canal is dry, as it is most of the time, the sand upstream of the ôÇgala will indicate just the right inclination for the canal. The next pile of rocks would have to be built no further up than the upper end of the stretch where this sand has been deposited. These piles of rocks together make the water flow controlled as in a staircase. If the canal is built in erodible masses, the canal may have many such stairs according to the inclination of the canal, but also according to the type of ground and the character of the water flow. The water flow increases as it gets closer to the cistern since the canal gathers more and more runoff along its trajectory. The side walls of the collection canals sometimes have similar technical aspects, that is, special placement of rocks of a certain size in specific locations and formations. Almost everyone among the locals seems to know the importance of this detail and the mechanisms behind it. The canals in erodible masses have to be constantly maintained and the correct spacing of the ôÇgala is one of the factors that reduces this work. Thus repairing it is something anyone may do if they coincidentally walk past one that is damaged. Understanding this detail, its importance and the necessary effort behind it, is an important part of the rainwater harvesting system.

This type of local knowledge that the ôÇgala represents is very practical in nature, thus even I, as an outsider, have some qualifications to understand it together with the locals. As Hutchins (1995) maintains, many types of knowledge are very much embedded in physical structures

and “material culture” around us. If one isolates the practical aspect of the local knowledge concerning the ôûgala, it can, in my view, easily be shared with the informants during observation and conversation. The materiality and practicality make it easily shared, in addition to the very open and apparent cause-effect aspects. The cause-effect aspect is obvious and demonstrative compared to knowledges of for example, local ground water dynamics or reasons for leakage in a cistern. These also impose practical and material frames for the knowledge, but also much more uncertainty and elusiveness, as these types of local knowledge cannot easily be tested and the causes and effects are not known completely. It seems that such topics are treated with much more “belief”, that on aggregate level produces more cultural explanations. Methodologically, cultural explanations were much more demanding for me as a researcher to grasp compared to practical ones.

It was quickly revealed that the technical detail mentioned above had a name, although most people seemed to look at it as a very normal thing. When I asked about the use (usefulness), very many different answers were given. “It holds the sand”, “It slows the water”, “It protects the canal walls”, “it collects the sand so we can remove it”, and in the beginning the different answers were confusing. None of the answers are “wrong”, but then I thought that maybe this question is one that is never asked in that way[42].

Barth (2002g) emphasizes that the setting of the social transmission of the knowledge is crucial when studying any type of knowledge as treated in the theory chapter. When it comes to how the knowledge of the ôûgala is transmitted, I do not have an exact picture, but maybe the locals just learn from each other by looking and doing. It also could be knowledge that is very self-evident, and does not need a linear explanation by language. Perhaps it is like asking how to use the brakes of a bicycle? Most of us can use a bicycle, but without knowing all the names of the details or how they work in a physical scientific way.

The same water structures as mentioned above with the same name are found as large structures in flood courses having the same function, but much larger, perhaps 2-3 metres high and made of enormous boulders. Once when I was in a conversation of how they were built and by whom, one informant said that the large ones close by the village were hundreds

[42] Sometimes the answer actually was wrong, for example if I was accompanied by someone who had grown up in the city and was very eager to give explanations to any question I had.

of years old. I had mistaken them for being built by machine because of the size of the rocks and he became very proud of “how strong their ancestors were”. Certainly his sets of ôûgala meant something not just practical to him.

Discussing the topic with informants makes one quite sure of the lexical meaning of the different details’ names, but becoming completely sure is difficult. Often one type of functional detail can have many names with sometimes slightly different meanings. The canal as an artificial water conveyor has, for instance, very many different names in the field area. Sometimes this evolves into a “game” of checking a large number of names and what they could possibly mean or not, and often informants disagree among themselves about the exact lexical meaning.

The knowledge of the cisterns is not only a common knowledge that is shared by all the locals; some individuals know more that others. Sometimes individuals or groups of individuals have special knowledge that is hired in for example as in the case of the traditional travelling well cleaners mentioned by Varisco (1982a:200).

The knowledge of the ôûgala can be said to be very “indexical” with the eco-technical possibilities and constraints, and it is expected that it has not as strong social and cultural aspects as the other type of knowledge that is treated next: Hygiene.

Education and knowledge level concerning health issues

As an introduction to the coming part concerning local knowledge of hygiene, I want to give some background information about local education situation.

Education in school can be said to be production and reproduction of knowledge. The local knowledge about water hygiene appears to be the cause for so called inferior hygienic behaviour when it comes to how to ensure water quality in relation to western standards. Episodes are many and narratives about how diseases are caught and treated the same. Fundamental knowledge of hygiene is lacking and a mixture of old and newer “folk knowledge” in the field of health and hygiene often deviate much from the same type of knowledge in the developed world. The cheapest and most effective solutions are often not

utilized, as there are strong local market forces represented by local “doctors” and pharmacists (Morris 1991).

Direct population statistics concerning education levels are hard to find, and when found, they are not very detailed. Literacy may be an indicator for understanding hygiene as a general indicator of education. The statistics from the Central Statistical Organisation, al-Jihaz al-Markazi li-l-Ihsa (1998), might not be directly applicable but give some indications:

Percentage of men 15-49 with complete primary education 61.0
Percentage of women 15-49 with completed primary education 18.2
Percentage of women who are literate 19.4
Under age of 5 mortality rate: 105 per 1000

Knowledge about how diseases can be prevented is considered by local intellectuals, GOs and NGOs as a vacuum that needs to be filled. This “lack of knowledge” is often seen as the reason for the lack of willingness by the locals to invest more effort and money in safe drinking water. The solution that often is presented is to fill this knowledge gap and the locals will manage the water quality correctly.

One might see the local water management compared to expert-bureaucratic water management as problematic, as long as the local knowledge is not sufficient to reach the water quality standards. However, these standards are set by outsiders, and the standards might not be the same among the local inhabitants.

The goals of clean water do not have to be a coherent set of standards within the village, but it is very rare that any of the outsiders are actually interested in what the villagers’ goals for what clean and sufficient water are. Such goals are of a very normative character, but still stated as fundamental truths in most of the development literature and even within applied social science. Access to clean water is stated as a fundamental human right and even social scientists often treat these standards as “truths”. This can make the analysis blind for the fact that the locals might actually have other standards. Here the “principle of charitableness”, as mentioned in the theory chapter, instructs the researcher to assume that there are some rational standards as goals behind the actors’ actions. These local standards for water quality are

important empirical data if we are to understand the logic behind the priorities and observable actions that again generate aggregate consequences.

Local standards of water quality

By local standards for water quality, I here mean what the local people present to me as different categories of water quality and the suitability of this water for different purposes. These cultural categories vary from person to person, and also according to different social statuses and groups, but certain generalizations can be made to give an overall picture. The local standards of water quality can be seen as a part of local knowledge.

There are three categories that seem to be present in the field area:
(1) Foul water
(2) Drinking water for animals and washing of clothes, kitchen utensils and body
(3) Water for drinking. The limits between these categories may change according to time when the need for water makes it necessary to redefine the categories.

1. Foul water: This category is usually applied to old water in the bottom of a cistern. Often some of the last centimetres will be left unused and other sources sought. This water has a colour and an odour, often a high content of mosquito larvae and garbage that has accumulated during the season. It is left unused and will sometimes disappear by itself by leakage or evaporation. Wastewater hardly exists but will fall under the same category, and is usually thrown out on the paths or the narrow "streets" between the houses where it flows for a short distance before it infiltrates into the ground or evaporates. Septic wastewater from bathrooms is led out through the wall and often through a pipe to a small infiltration area outside the bathroom or sometimes into an open or covered small infiltration well. Bathrooms are not common among the poorer segment in the villages but this varies much. It also depends on how you define a bathroom or a toilet. Often there will be specific places of a private character around the village that will be used as toilets. Foul water is never reused. It is considered unclean.

2. Water for animals and washing: This water should be clear (safi). However, immediately after the cistern has filled, the water will be turbid for some time and this is considered

normal. The green floating plant, Tumshugh does not start to cover the cistern until after some time. There are different opinions about the Tumshugh, but few people would reject using water where this plant is present. Only occasionally will the floating plant regularly be cleared away or skimmed off. This practice can often be observed in private cisterns for drinking water[43]. The floating plant adds a slight smell of "green" to the water and often a slight smell of rot as well. There are different explanations of where the plant comes from; some say it comes with the rain, others say it comes from small plants adjacent to the cistern that drop some kind of invisible seeds into the water. Or, that it just comes by itself. The benefit is that it keeps the water clearer, colder, "prevents the wind of taking the water"[44], and also "eats the impurities" as several informants have mentioned. Different types of water insects are usually present and this is also considered normal. In mosque cisterns where the water is used for religious cleansing, the ablution (wuḍū'), the floating plant is cleared away, but a smaller algae appears and covers the water, and even colours the water body green. This water will be considered normal. It is always said that some of the people in the village drink cistern water. But what to use as source of drinking water is a slightly more sensitive issue:

3. Water for drinking: The majority of people will put effort into getting drinking water from a spring, ghayl. In villages very far from springs, poor people do drink from cisterns, but then usually only from certain "good quality cisterns" where the catchment area is mainly rocky and where the water will be clear (ṣāfi). Sometimes there is an emphasis that there should be little human or animal activity in the catchment area, but most important is it that the cistern is located somewhat far from the village and that the water is clear. Appearance of animal excrements in the collection canal is not considered that important. They can be brushed away in some cases, or "the first flush principle" can be applied. This means that the water is led past the cistern for the first rain shower to flush the catchment area and the canals. I do not know to what extent this is actually performed. It was only mentioned by some of the informants. Private cisterns for drinking are often protected by a wall or a fence and also partly covered, often with corrugated iron sheets supported by wooden beams.

At the spring, where anyone has the right to fetch drinking water, the water is filled into plastic jerry cans, usually 20 litres, either by dipping the container itself into the pond where

[43] The floating plant is especially removed in cisterns for irrigation as it may clog pumps and hoses.

[44] More about evaporation in given in part 2.3

the water comes up, or by using a hose and siphoning the water out. If the spring appears as a pond in the wadi, there will often be fish in the water and sometimes a thin film of something like fat will float on the top. This is not considered problematic and any perennial spring is said to provide potable water. The water will be quite hard and sometimes have a slightly grey colour. High mineral and salt contents can often be tasted and it is stated by a wide range of the locals that this is the cause of the very high prevalence of kidney stones in the area.

In the villages, that is in the rural areas, water is considered clean for all purposes except drinking if the water is without smell and is clear.(Mi safi wa ma fish shamm). All water becomes clear after settling in the cisterns for some time.

Social statuses and water quality categories: Any of the three categories above may be changed in the direction up or down on the presented scale of ranking according to social status and water need at the actual time. Poor people and families with little resources to spend on getting water from a spring, will tend to say that cistern water is ok to drink. Especially for instance for tea or food where the water is boiled anyway. The families of higher positions tend to say that cistern water should be used as little as possible and tend to rely on other sources such as springs or water trucks. Teachers and village intellectuals always describe to me cistern water as “backward”.

My statuses as a guest, expert, educated and rich, methodologically pressure the informants’ answers into the direction that cistern water is “backward and should not be considered safe”. However, sometimes the opposite may occur; because I represent possible future development aid as mentioned in the methods part, the situation is described as “very bad” and that “the spring is very far and many have to drink from the cisterns”. Often the case is that the actual informant “will however never drink from a cistern” as “he knows that it is harmful” Getting less-polished answers about these questions is easiest when walking in the fields outside the village with local farmers and not asking directly about it.

Diarrhoea and waterborne diseases in general, cause high death rates among infants in the field area. It was said by a western female NGO health worker that is was common local belief that diarrhoea was caused by exposure to wind and that locals treated it by keeping the child warm.

Diseases are often treated by “wise women”. In the lower areas, most children are burn-marked to relieve them from “strong fits of fear”. This mark is often in the middle of the forehead. A handful of close informants that trusted me, also told about spirits (jinn) and how they got rid of them. The anthropologist Frode Jacobsen (1998) wrote his PhD thesis on the topic of local knowledge of cause and cure of sickness among the Beja people in the Red Sea Hills, Sudan. He uses informants’ narratives to present how Beja people conceptualize different illnesses. Among others, he illustrates the perception of contagion that often is completely different from scientific medical knowledge. However, through telling of narratives, the locals still manage to have a wide and rich “cosmology” of different diseases’ causes and respective belonging treatments.

Thus, local perceptions of illnesses do certainly not have to be lacking per ce. On the contrary, local knowledge of water hygiene in the field area is most probably as rich as on the other side of the Red Sea. It is a knowledge actually that does take into account that cause and effect are logically related, but both the causes and effects are culturally interpreted and culturally logical. If “educated” health workers are to educate the locals in better water hygiene, they would have to compete for the trust and confidence in that their knowledge is more true. The locals would have to accept completely new theories. How does one prove the theory, in such a cultural setting from the field area, that diarrhoea is caused by biological contaminants spread by water?

As a summary to the above paragraphs, I will briefly conclude that water quality is mainly judged from clearness, smell and temperature and very rarely from understanding of biological contamination. Biological pollution is not expected, unless a cistern is located immediately below houses. If possible according to circumstances, spring water is preferred for drinking. Some springs are said to have an excellent taste.

Fig. 36. Recreation! Many of these mountain people are good swimmers. Children have a great time playing in the cisterns. Some villages prohibit swimming in certain cisterns because the water is used for drinking. A fine of several thousand riyal may be the punishment (more than 100USD!) Schistosomiasis (bilharziasis) is a severe health risk and is common in the entire area. The figures are uncertain but between 10 and 60 % infection rate is normal. Annual, complete drying out of the cisterns, or water additives would eliminate the risk of infection substantially. The vectors are humans and some special types of snail. It causes bloody stools and diarrhoea and also causes malnutrition and may lead to serious kidney problems. (Bamashmoos, Nagi, Kumar et al. 1999) People have mixed ideas about the green floating plant (tumshugh). No doubt can both cisterns and springs be meeting places in an otherwise busy day, perhaps especially for the women.

Spread of local knowledge: A case of urban garden rainwater harvesting

Before discussing the differences between the various types of knowledge, I want to focus on a small phenomenon that is not that important in applied science, but that does illustrate a form of local knowledge transfer. Since most of the inhabitants of the city of Hajja come from the countryside from all over the governorate, they still know the basics techniques of rainwater harvesting.

There is generally no storm water collection system in the city so the streets may carry runoff for a long stretch before draining into the wadis. Only in some streets are there functioning ditches on the inner slope to lead storm water, still these might end up on another crossing street and cause much gravel deposit that will have to be removed by the éAkhdâm, the servant “caste”. The streets carry a substantial runoff during rain as mentioned, and they are important catchment areas and leading canals at the same time. If someone has a garden close by the road, a hole is made in the wall and a diversion dam constructed that might be extended into the street just during rain if necessary. In that case, only the innermost structure of the dam will stand ready in periods between rains, as it obviously is an obstacle to traffic. One such structure down from Ðhahrayn towards al-Qalaôa, extends more than a metre into the already narrow street and is made of concrete building blocks so that driving over it is not an option. Under the stones and concrete blocks, pieces of cloth are put to prevent leakage. Sometimes small sacks of sand are used as temporary dams or extension of more permanent ones. In other cases, water flows almost without help into the garden. The garden is then filled up within the bund as in supplementary rainwater irrigation mentioned in chapter 2.2. When no more water is needed the diversion dam is dismantled or the hole in the wall closed. If just a little water enters the plot, it might be further led to base of the plants by making canals and depressions guiding the water where it is needed most. Gardens often have coffee and fruit trees and may seem very “practical”. Perhaps “hobby farming” is a better term.

Rainwater harvesting in the city is mainly practised in the parts of the city that were built as the city grew after the revolution outside the dense old village cores. The central market area and some of the most “public” streets seem not to have any runoff collection, rather this is found in the more established residential areas outside and between the old village cores such as along the street from Ðhahrayn to al-Qalaôa. Here several intake dams can be observed.

As the city gives way to farmland there is a zone where agricultural terraced land has been sold for house building. This land is not maintained for agriculture and hence no proper runoff management is performed other than preventing storm water from destroying one’s property. This zone then gives way to proper agricultural areas with both cereals and qat where runoff is again almost completely a managed phenomena like anywhere in the rural areas.

One reason why runoff is collected for irrigation of gardens might be that it is a way to save money by not paying for water from the public waterworks or a water truck. Few people

would justify paying money for water that eventually will be used in a garden for hobby or recreational value.

Fig. 37 The local knowledge is also transferred to the young generation that has grown up in the city. This picture shows rainwater harvesting for garden use. The rain was very light, but at the beginning of the growth season, any water is appreciated. The tank behind is connected to the public waterworks and has a floating vent that will close when it is full. They are usually located on the roofs so that the water will flow to the taps by gravity. The system is not pressurized, except when delivering the water approximately two times a week. This is common in all of Yemen and reduces leakage and problems of permanent low pressure in the parts of the city located at a high altitude. This eases the rationing of water in periods of low availability in the well fields. It is a way to make the rationing fair, so that all parts of the water grid will be completely pressurised for the same period of time. In Hajja, the system is also only pressurised during daylight hours to prevent qat irrigation with subsidised water. When this new practise was recently introduced, the water consumption fell by 30% immediately.

Comparing different the types of knowledge treated above

As mentioned earlier, the very practical and testable local knowledge type of the ôûgala has a very clear aspect of cause-effect. Its name and ways of explaining the function may vary greatly. Despite that probably some mistakes are made when using this technique in canal management, it is in general, a type of knowledge that can serve as an example of “indigenous

ingenuity". The technique may be a good example of local knowledge being a well adapted technique suitable for local conditions when taking into consideration the cost of other alternatives.

The other type of knowledge, hygiene, is according to outside actors trying to improve living conditions, the hygienic practices are actually relevant causes of high mortality rates. It is a type of knowledge that is not regarded as positive by actors in development and applied science.

First, I want emphasize the level of perceptional control the locals have over the "eco-technical" content of the two different types of knowledge of respectively the ôûgala and hygiene: In the first case there is an obvious practical control that can and will be tested for each rainfall. Through continual maintenance, people observe and make small improvements in their collection canals. In the case of hygiene, however, the connection between polluted water and serious disease is not that obvious. Keeping the catchment areas clean is not something that one person can do without the collaboration of the other villagers. Even if this was done, there are several other hygiene risk factors that could just as well be the cause for continued presence of diseases.

The cause-effect relationship is not apparent or obvious. It seems that the locals adapt to the present situation by accepting it and lowering the water quality standards. The problem is "solved" by closing the discrepancy between the "perceived situation" and the "wanted situation" simply by lowering the standards of the "wanted situation". This is an interpretation, but it is an empirical fact from the field area that somehow, the knowledge of biological contamination of water and its connection to disease does not present a culturally accepted truth. The theoretical position of this thesis will maintain that this is because of certain eco-technical, social and cultural possibilities and constraints that are connected through social interaction. The local knowledge is also part of this interaction through daily discussion, use and transmission. A "discourse of hygiene" may be one such aspect of the social interaction.

Ralph Nicholas use of the concept of "regularities" (1969), as mentioned in the theory chapter, also gives valuable insight to this issue. Causal connections that are observable for outside experts are not necessarily observable for the locals and hence, these connections

cannot be expected to be considered. These connections can exist in the researchers models as for example “deaths due to lack of hygiene knowledge”, but in the locals “models” of reality as a basis for rational behaviour, they simply do not exist.

Fatalism is a common aspect of the local belief, however, it is also common local belief that individuals can and do choose their own actions and have a free will. This philosophical “contradiction” is not considered problematic at all. When asked about the reason for a specific incident, both explanation models are commonly given by the informants. If God is introduced as a direct causal factor there will, expectedly, be social and cultural frames for where and by whom this argument may be used. The same can of course be the case with other spiritual forces as well.

It can be remarked, that although rainwater harvesting techniques have spread to the city, ideas of hygiene have not spread into the rural field area. This I to attribute to the fact that the knowledge of hygiene is much more complicated, less indexical, more value laden and more “situated” in social and cultural aspects. The eco-technical aspects of the knowledge of hygiene do not seem to be clear for the informants and thus the social and cultural aspects take the force of explanation.

The aspects of cistern leakage, the use of cement and local perception of ground water can be seen as cases of local knowledge that lie between the two rather opposite cases discussed above. They are practical topics, but at the same time they cover topics of “mystery” as well. The local experts concerning these issues cannot always explain rationally why they know what they know. As mentioned in the theory chapter, the anthropologist Trevor Marchand (2001) goes into the role of apprenticeship in minaret building in the Yemeni capital Sana’a. He explains how a master will not, and cannot, teach everything by words. The knowledge is hidden even from him, inside himself. Through long term social relationship of teaching and learning the master chooses a few students to “be worthy” of rising in the guild’s hierarchy. The knowledge can thus also be perceived as a kind of substance or value that is not even formulated in words. This aspect was not investigated during the fieldwork and may be an example of the necessity for long term fieldwork in one locality to get such insights.
It was often perceived that I was a technical expert, as most of the other foreigners in the field area are.

3.5 The case of Banî Ismâîl

This chapter is a case from outside the field area, in an area that is comparable in all the main aspects of local water management. The case has raised several important questions about local knowledge. First I will give some background information.

Banî Ismâîl is a very large sub-district under the district of Manakha in the Haraz mountains in the escarpment area west of Sana'a. I travelled to the village of Dahban for a personal visit, but village and the trip from the tarmac road into the village showed two distinct different characteristics from the field area: The exceptional use of mulching stones and traditional cisterns that were all private and covered with a stone dome.

Dahban is one of the northernmost and lowest villages in the northern end of Banî Ismâîl and the area is very underdeveloped and poor. From the village one can view northward to Banî Saôd, the city of al-Mahwît and all the way eastwards along the ridge of the Governorate of al-Mahwît. Wadi Surdud far below the village, is perennial, but lower than the village (about 1200 masl) there is no agriculture apart form some herding of livestock. There are no jobs outside agriculture and work migration, and remittances have economically integrated this remote village into the rest of Yemen just as the described situation in Hajja. The population follows the Shafi' (shafiôî) school of Islam as most of the lower areas in Yemen do. The village is located at the foot of a mountain massif called Haraz that is inhabited by another religious-ethnic group called Ismailis. Despite the name of the administrative district, the Ismailis only inhabit the higher peaks and ridges within it, but they have obviously historically been powerful in the area and much of the land in the village is owned by Ismailis from areas higher up. There are some springs and wells in the village, but these are very weak and during the visit the water situation was serious. Very expensive water was trucked in on the back of pickups for rates as high as 3000 YR /m3, that is circa 15 USD /m3. The water in the cisterns was being sold internally within the village to neighbours that ran out of water for 50 YR for a "dabba", which is a plastic jerry-can also common in the field area that holds 20

litres[45]. This gives a price on domestic water of circa 13 USD / m3 ! The common spring in the village that all families had rights to, allocated according to time, was almost dried up. The explanation for this was that there had been two years with little or no rain. Coffee trees and qat trees had in some places started to die, but watering from truck is only economically possible along the road before the steep descent down to the valley where the village is located. Irrigation for qat seems rational to the farmers for a price not much higher than 1000 YR, or circa 5 USD /m3. This seems to be a relevant figure for the high winter price of water in much of the western escarpment area (Abdullah et al. 2000). In the following, I will present the two main findings of the visit:

1. The traditional village cisterns covered with a rock dome and owned by families

Fig. 38 The village of Dahban in northern Bani Ismail toward the south with an old qadad treated cover-structure over a cistern. Entering through a small door that can be locked, the cisterns look the same here as in Hajja. The covering structure is made with cantilevering masonry with qadad between the stones. The internal

[45] Petrol is also often measured in “dabbas”.

shape is that of a dome, but the stones used are placed horizontally and the stones are progressively placed a little bit farther in for each round. This technique was common in Hajja but only in old "saqîf" or "sabîl", that is roadside shelters for travellers and herders. The size seems like the normal size in Hajja, perhaps a little bit smaller. The only road into the valley comes over the ridge on the upper right. Here, as in Hajja, the road was built by cooperation among the locals. The foreground is a typical old graveyard. The soundness of houses up on the ridge gives the impression of power over the tenants that live further down. The shaykh of the area lived up on the ridge. Sharecropping is common.

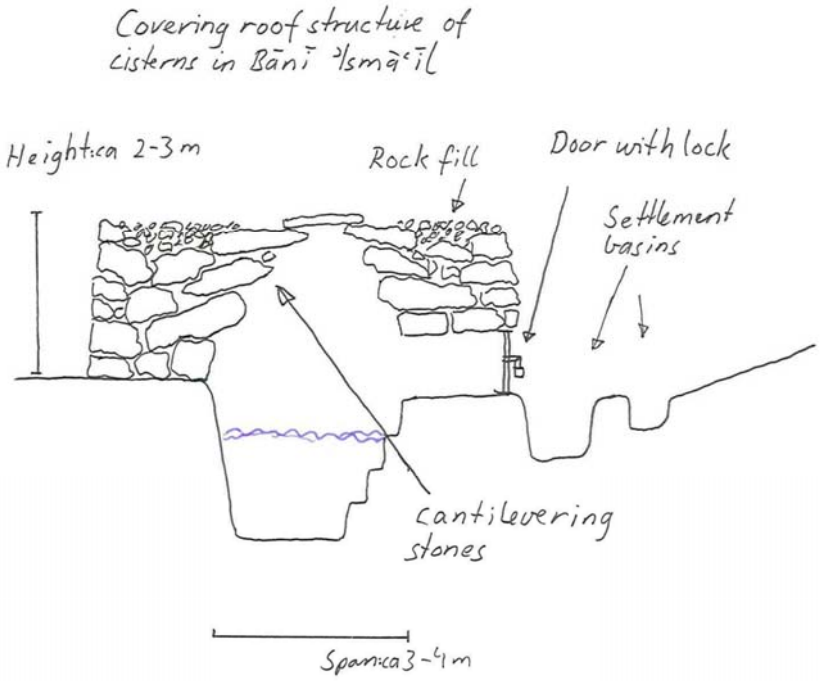

Fig. 39 Cross section of the roof structure. Note how the cantilever technique is used rather than vaulting. Cantilever structures necessitate strong rocks, but do not need scaffolding during construction as vaults do[46]. The cistern on the picture above also had qadad reinforcement between the stones on the inside so there were almost no holes.

According to informants, all the cisterns were private, owned by individuals or families.

It is never the case in Hajja that all cisterns in a village are private. There, it is considered a norm that the managing of cisterns is an issue common for the village as a unit. Most of the houses in the lower part of the valley were less than 50 years old and if there was a strong influx of migrants at a recent time in history, this could be a cause for the privatisation of the cisterns as an insurance for the original inhabitants.

In his PhD thesis from the mountains of al-Mahwît, a governorate to the south of Hajja and north of Bani Ismaîl, Richard Tutwiler (1987:87) states that the practice of family owned,

[46] The same technique is used in very similarly built and sized potato storing cellars in western Norway.

dome-covered, and locked cisterns is common in much of the mid and lower reaches. Water supplies are kept privately. He also states that in general, the tribes living in the higher altitudes, seem to generally have more shared infrastructure such as cisterns and threshing floors.

When talking to taxi drivers in Sana'a that come from all over Yemen, it is however easy to hear that there is not always a clear perception of the water management situation when it comes to what the management unit is, and what rules apply to local domestic water supply.
The buying and selling of domestic water between families would in Hajja be considered highly immoral. There, the concept of owning the domestic water supply commonly on the village level is perceived as the only "original" domestic cistern water management. Sharing is thus a way of "water insurance" and men in the village are considered "equal" contributors in water management despite other social differences. This situation is perhaps changing with the introduction of private irrigation cisterns.

2. The mulching stones:

The elaborate mulching stones are unknown anywhere else in Yemen according to Frederic Pelat (personal communication). He runs an NGO that tries to enhance contact between western scholars, local farmers and Yemeni agricultural experts on the topic of dry-land farming. Holding conferences and meetings with local farmers from all over Yemen, he states that the use of mulching stones are limited to Bani Ismail only, and that farmers elsewhere have never heard about it. It is certainly not used in Hajja. Then the question is; why is this technology not known and used in the field area?[47] Some suggestions might be:

1. The special role of the Ismailis: The largest group of Ismailis today lives in Pakistan and thousands of pilgrims come to the founders tomb just south of Manakha every year. In the past, the southern province of Najran in Saudi Arabia was Ismaili before the Wahhabis took over and throughout the Mutawakkilite kingdom 1918-1962 (the "Imamate"), the Ismailis in the Haraz mountains played a very independent role in the area. However, the use of

[47] The distance by "traditional travelling" is perhaps 3 days and by car it can be done within 6-8 hours.

mulching stones is confined to Bani Ismail only, and are used by the Shafi' population as well, and not in the wider Haraz mountains where the rest of the Ismailis live.

Fig.40 Mulching stones in lower Bani Ismail. The trees are coffee trees but the drought has made them lose their leaves. The terraces seem quite normal but the astonishing thing is that they are covered with rocks (circa fist size) and the depth of the rock-cover ranges from almost nothing to well over a metre. Different patterns and shapes can be seen. The feature is called mazil (mawazil) and it is said locally that its benefit is to protect the soil from erosion and retain moisture. Bani Ismail is in general very known for its type of Yemeni coffee named after the area.

2. Special local eco-technical conditions: the area is lower in altitude than the rest of the coffee growing Haraz mountains and hence warmer and dryer. Reduction of evapotranspiration thus becomes more important. The soil also seems quite sandy and it would be expected that the soil here could not hold its humidity as would be the case if it had a higher content of clay. As seen in the picture, there are few big trees that give shade as is often the case in Hajja, but in Bani Ismail most coffee is grown on dryland farming. The big trees can only grow in a "leaking" spring irrigation scheme. In Yemen in general, there are two main types of coffee, one that is seasonal that can handle drought, but yields less, and one that has to be irrigated during the winter months from a spring and that will yield several

times a year. Both types may have supplementary rainwater harvesting irrigation. The mulching stones were not only used around coffee trees but also around qat trees.

One other important aspect of very localized knowledges might be “fashion”. As in popular architecture and other types of fashion it is clear that there are strong forces that compel the actors compete internally in producing certain valuable material symbols that make sense only inside a certain cultural group. It is only an unstudied hypothesis, but if the mulching stones do have such cultural aspects, the general theoretical connection between “fashion” and local knowledge may be a valuable factor in future analyses.

The reasons for the differences in practices between the field area and Bani Ismail regarding the covered private cisterns and the use of mulching stones, remain a question, and it points to the fact that knowledge and practices can be very local, also geographically.

3.6 Concluding remarks

The local water management in the field area in Hajja is clearly undergoing changes. As demonstrated in this thesis, it might even be said that continuous application of ancient technology is taking place because of, and not, despite these changes. The integration of the field area into the rest of Yemen, the region and the wider world, is the largest change. The introduction of roads and other types of new technology has been a significant factor. However, the changes, even if seen as "development", have been unevenly distributed in the population and geographically within Yemen and within the field area. Large groups of the population still live in extreme poverty and get their water from seepage springs and cisterns. The difficult situation of water quality and quantity relates to many aspects, but few of them will probably change with the current constraints that the locals are facing of economical character as well as the types of knowledge available in the present eco-technical, social and cultural frames. Thus, the changes that local water management has undergone since the revolution have happened through so called "windows of opportunity" where certain locals have been able to take advantage of these opportunities. The investment strategies of the private qat irrigation cisterns, for instance, can be seen as positive economic spirals that increase some individuals' position relatively more than others. Water for domestic use does not produce economic value by consumption, on the contrary, it is consequently not seen by the locals as an investment in the same way.

As mentioned in part 3.3, many of the locals have adopted low standards of water quality and quantity as a way to adapt to the situation and this "strategy" seems to be culturally acceptable in large parts of the population, especially in the rural areas. Thus the combination of lack of economic incentives and presence of cultural accept for low water standards, can in a very simplistic way be said to be important factors behind the slow development of domestic water supply, compared to the development found in irrigation cisterns. The average actors behind the two different water supplies are also slightly discrepant: The irrigator is a farmer that has had the economical or social resources to start the investment process and can usually afford adequate supplies of clean domestic water. The consumer of unclean and scarce domestic

water is on average poor, has little irrigated land, is a day-labourer, and generally does not accumulate economic capital at all.

The water sharing ideology that was supposedly present in the past is under pressure from the presence of large amounts of private expensive water in the water landscape. But perhaps the reality of the past was not as idyllic as the informants have narrated about. As mentioned in part 3.4, in a synchronic comparison, a rather short distance away, water is managed more privately.

Research based on a long term stay in one location is needed to find out more about the local level of village water politics. In this thesis relevant statuses and general processes have been pointed out from the field area and not from a specific village. The pragmatic rules of the water management, however, seem to be very short lived and also related to specific political events. They are also difficult to access as an outsider, be it for foreigners or a person from the neighbour village, due to the sensitive character of the data. They are nonetheless important to focus further on, since they obviously represent an important part of the general management framework.

As pointed out by several of the theorists, the adaptation of human beings to their local material surroundings is a strong factor in social and cultural development of the society. I therefore first dealt with the eco-technical possibilities and constraints and follow the physical water, first as a broad background presentation and then more explicitly about the specific water uses and their respective technologies and practises. The rainwater harvesting cisterns have been the main focus. The focus was kept more on domestic water management rather than irrigation, as a topic that has been given very little attention in academic literature compared to the latter.

The social and cultural framework around the actor has not been given the same depth as the ethnographic details of the cisterns. This is attributed to the resources needed to undertake such analyses. However, the qualitative approach has pointed to several important issues of social and cultural character ranging from management laws and ownership structures, via economic mechanisms and possible investment strategies, into the perspective of local knowledge.

When it comes to answering the research questions in the introduction, I will here shortly comment upon one by one, and state where in the thesis they have been treated and how they have been answered.

What can be found of local water management in the field area and how is it performed?
This question has been answered by the whole thesis on a general level. Some parts have as explained before, been treated more in depth than others.

What are the eco-technical, social and cultural possibilities and constraints in local water management? How do these possibilities and constraints affect each other?
The perspective used in this thesis, which is essentialised in the Barthian model in fig 1, has been based on the ideas of Fredrik Barth (1994a). It maintains that social interaction is the focal point with three feedback loops connecting the social interaction of water management and the surrounding framework of eco-technical, social and cultural possibilities and constraints. This model has structured the identification, analysis and presentation of the actual data, which is mainly of ethnographic character.

What is the present day role of rainwater harvesting in local water management?
This question is more specific, but has also not only been answered in one section. The role of rainwater harvesting in local water management is very strong, although interconnected with other water sources in the field area. This has not been quantified in terms of amounts of water, however, throughout the thesis I have described the general importance of rainwater harvesting which in the field area is very important both in agriculture, but also in domestic water supply, especially in areas of low quality road connection. The price of water can reach in many areas, 5 USD / m3 in periods of the dry winter months and this puts severe constraints on domestic water use as well. But most of all, the high price is a strong economic incentive to invest in rainwater harvesting and storage facilities. As the user-value of domestic water is compared to the price, rain water harvesting for domestic use is not considered as an economic investment strategy. This leaves the women with a very high workload, especially in poor rural families, as they often have to supplement the lack of water from cisterns near the village with water from distant laying springs. The use of traditional rainwater harvesting poses severe challenges in hygiene questions and combined with social and cultural factors described in part 3, this leads to a general very high prevalence of waterborne diseases.

What forms of local knowledge are the locals using in their water management and how is this knowledge connected to the possibilities and constraints in the water management?
This question is partly answered by the ethnographic descriptions of how the cisterns and other water structures function, but also how knowledge about the local society and culture is important in the actor's rational choice. Different types of knowledge have also been discussed and related to different aspects of the knowledge such as social and cultural situatedness and its relation to ways of explanation and legitimisation. The topic has been treated throughout the thesis, but especially in part 3.3.

Why is the water management regime continuing to exist and how are new factors incorporated? What is the balance between continuity and change?
Local water management, especially domestic water management, has perhaps not historically been as important as agriculture and food production as a structuring force of the society as in how the area has been settled. Water to make food (irrigation) has been more important than water for domestic use. However, this has changed in modern times, especially as the water can be bought and sold in one semi-integrated water market where the main internal eco-technical differentiating barrier is the quality of road connections. The economic value and price of the water is driven drastically up by the profits from irrigated qat in dry periods. This change also includes aspects of continuity at the same time as it gives an economic incentive to continue to harvest rainwater. This can be seen in new large cisterns for qat irrigation, but also in restoration and maintenance of smaller, traditional, even common village cisterns. The phenomenon of large new private rainwater harvesting cisterns for qat irrigation can be partly seen as a usage of traditional technology combined with present day possible investment strategies. This can be seen as new *technical facts* as Nicholas (1969) labels the concept. The wider local water management in the field area has thus gotten a new "reality" that locals have to take into consideration in their decision making. The local knowledge and technology thus "live on" in a new setting.

Some delimitations have to be made in a project that has firm frames of time and length. The topic of development is perhaps the most significant issue that has been omitted. However, development and applicable social science are some of the main fundaments, or behind laying motives for both myself and many of the contributors to the thesis. As a suggestion for further studies, I will here emphazise that applied social science in the field of development must be one of the most important tasks to undertake. The theoretical concepts and analytical tools in

this thesis are arguably usable in such a task. Again, as stated in the beginning, academia can have much to contribute regarding the necessity to analyse the causes of the present day situation in many developing countries. An actor's model of resource management that can take into account local level politics, combined with a critical understanding of the role of local knowledge, is in my opinion a useful starting point.

Finally, I would like to point out that many of the topics mentioned in this thesis could have been dealt with more extensively. I have felt like I have only scratched the surface much of the time and I hope that this thesis will stimulate further studies in these topics. Local history, ethnography, geography and social studies are just some of them. I believe there is great potential among Yemeni intellectuals, both the local ones in Hajja and others to still pursue this knowledge, even under present conditions and climate. Wider and deeper cooperation between foreign experts, devoted locals and Yemeni governmental civil servants is a path that can only lead to great insight. If this thesis could have been an inspiration, or a starting point, for one person to become interested in the complexities of society in Hajja, the effort behind this thesis will be greatly rewarded.

Part 4

Appendixes and bibliography

4.1 Technically related water terms from the field area

Singular	Plural	Lexical meaning
(arranged according to root)		
birka	birak, buruk	Rainwater harvesting cistern.
barûk, barûka	barâ'ik	Rainwater harvesting cistern
	birwak	This uncommon plural may be used by people from further south.
mâ'jil ma'jil (SA)	mawâ'jil	Cistern for storing water from a spring, until it is full and the water is let through a canal network for irrigation. This is coherent with the use in al-Ahjur. (Varisco 1982a) Another distinction sometimes given is that a birka is large and a mâ'jil is small.
mâ'zil	mawâ'zil	Mulching-stones covering the terraces of cash crops in Banî Ismâ'îl (not from Hajja!)

jɑ¢yish jɑ¢’ish (SA)	jawɑ¢yish	“Dugnad” Communal working action for maintenance (for common infrastructure work in the village).
masqɑ¢	masɑ¢qɑ¢	Common name for runoff collection canal. Root s-q-y
sɑ¢qiya	sawɑ¢qi	Runoff canal, sometimes explained as a larger canal. Also drainage canal to guide the water safely down between the terraces if the catchment area above is large. Form two of the verb means to irrigate.
siqɑ¢ya		Little cistern or basin, often for drinking water along the old roads or even a small basin inside the house.
sayl	suyɑ¢l	Flash flood, body of flowing water in an otherwise dry water course.
sayla		The (dry) bed between the banks of a flash flood water course. A wadi in narrow sense.
sharm	shurɑ¢m	Runoff collection canal.
mashanna, mishanna	mashannɑ¢t	Settling basing to prevent sediments from entering the cistern most common immediately in front of it. In local dialect this is also means a sift.
shuôb		Same as sɑ¢qiya

sabʿb, sabʿba	éasbʿb (no plural?)	Runoff (exact translation), water that gathers on the ground during rainfall.
tasrʿf tasrʿf (SA)		(lit. diversion) Spill-over, overflow mechanism in masqʿ or the cistern.
sinʿfa (kusnʿfa?)		Stone that acts as a “pulpit” at the rim of the cistern from where the water can be hoisted vertically up even though the cistern walls slope inwards toward the bottom.
ôubr	ôubʿr, éaôbʿr	Terrace, mudarraja
ôubr		Canal conveying sayl from the sayla to the field.
maôdal	maôʿdil	Same as taqaçuô
ôuqala, ôʿqala		Small dam in a canal or flood-course that retains sediments and hence controls the steepness, the speed of the water and erosion. The root ô-q-l can mean to “detain, confine, Wright p. 737” , and in dialect used when binding the knee of an animal. See also Lane (1874:2113). ħʿqala: Some informants suggest the letter ħ instead of ô but this is explained rather as a temporary hole to gather clean water in the wadi bed.
HD: ”tagʿda”, taqʿta SA: taqʿtuô		A controllable diversion point in a canal, either between two cisterns having the same collection canal or in an irrigation scheme.

qaêêd (HD: gaêêdh)		Traditional cement. See part 2.5
maqôad	maqêôid	Same as ôêqala
manshar	manêshir	Stone framed- or reinforced overflow point, often from one terrace to another.
nêra		Burned lime, in the past locally made from burned rock.
wêdi	wudyên, éawdiya	Often translated in written sources as a intermittent water course, but is often used for a whole valley or even drainage basin excluding the higher half of the topography. I think “valley” is the best translation. (Many of these terms above are given in Varisco 1982)

Modern words
arranged
alphabetically

bumba	Pump driven by a large heavy semi-diesel engine.
dêêmêt	Electrical pump
drêyil	Drill (for well drilling), a drilled well

kumbrɨ̃sh		Mobile petrol chisel hammer needed to cut rocks for masonry, to make new water structures and to divide large rocks into portable pieces that is an obstruction for new water structures.
layy		Hose
madakhkha(SA)		Pump
majnũn		A small water truck circa 1,5-5m3
masũra	mawãsĩr	Pipe (Wehr 1979:1043)
mãtur		Same as shaffãta
mitr		Water metre, counts cubic metres
shãwil		Wheel-loader or bulldozer
qallãb		Converted water truck, with fitted tank, but originally able to tip the loading area. q-l-b to tip.
tarmĩm		Restoration
tasrĩb		Leakage
wãyit		Medium to large water truck
winda		Unit; one cubic metre

Most of these terms are pronounced in field, not written, but I try to make informants write the word to get a written recording as well. However, it should be noted that the letter q is always pronounced as an English “g” as in “golf”. See also the transliteration key.

4.2 Transliteration

Transliteration key

Consonants according to the sequence of letters in the Arabic alphabet:

é(hamza)	s	l		
b	sh	m	Vowels:	
t	ṣ	n	a	ā
th	ḍ	h	i	ī
j	ṭ	w	u	ū
ḥ	ẓdh	y		
kh	ô			
d	gh			
dh	f			
r	q			
z	k			

T’ marbūṭa is written as a final “a” and in (genitive) construct “at”.

The nisba-ending is written “-iyya”

The definite article is always written “al-” with no indication of assimilation. In certain lower parts of the field area the definite article is “am”.

Plural masculine ending is sometimes rendered “-īn”. This applies to occurrences where the term was used in speech and no written convention exists. Note that cases are generally omitted in dialect.

Abbreviations:

SA: Standard Arabic

HD: Hajja Dialect. This is sometimes given when pronunciation deviates much from the written or SA.

Comments to the transliteration and the usage in this thesis:

There are many opinions of correct transliteration:

"ultimately any faulty or inaccurate transliteration scheme is "rot". " (Varisco 1982a:xxviii)

The system of transliteration outlined corresponds to the system suggested by The International Journal of Middle East Studies, (IJMES), "Instructions for contributors" under the paragraph of "Transliteration System" http://assets.cambridge.org/MES/MES_ifc.pdf .

In my university it has been encouraged to use the standards of The Journal of Arabic and Islamic Studies. The present font is called JAIS1 TTW and is freely available on the journal's web pages. In the beginning I used my own system, based on characters already present on the standard English (and Norwegian) keyboard. Hence, I rendered emphatic letters in capital, two vowels for long vowels, "3" for the letter ôayn and a " ' " for the hamza. This had the advantage that all letters could be written and read by any computer program. The JAIS1 TTW may not appear correctly in all progams, and will certainly be impossible to work with on computers where the font has not been installed. However, for purposes of style and correspondence with common transliteration standards, I believe the system outlined is one of the better options available. Many scholars of Arabic seem to use Macintosh resulting in easier treatment of the topic, but this is not an option of choice for many users.

Note that JAIS1 TTW is not applicable to some necessary programs such as:

"Paint": This program was used for the maps. In that case " ' " has been used for ôAyn in important cases.

"Endnote": The emphatic dot seems to disappear.

Some of the weaknesses of the transliteration key might be confusion if there is a k and subsequent h that will look like the letter kh. The same is the case with d-h, g–h and t-h. Some choose to solve this problem by writing a line under the kh when it functions as one letter. I have chosen to rather point out any possible misunderstanding and use the simplest way, that is, without the underlining. Knowledge of the most common word patterns will exclude most misunderstandings anyway.

The tæé marbæta is written as a final “a” as nunation is normally omitted. If nunation applies the tæé marbæta is rendered “t”. Thus, we get “atu” “atun” etc. Whether case endings are used or not, they are usually separated coherently. Finally, éalif ætawæl and éalif maksæra is not differentiated but this might belong to minor details. The final long vowels in SA such as the adjective “yamaniæ” will always be pronounced yamaæni or yamani and citations will be tried transliterated as spoken.

The dialect in Hajja, as for most of northern highland Yemen, has a “g” as in “golf” as a pronunciation of qæf and dhæ for dæd. The final tæ’ marbæta is often close to the letter “e” as in English “end”. I have chosen use SA transliteration here and in special cases to just point out the difference. Nouns that have conventional spelling in English will be used accordingly, i.e. Quran for Quréæn. Whether to transcribe pure SA or pure dialect exactly as spoken is a difficult balance since ethnographic data and “deep text” is lost if only SA is used.
Emphasis is not put on transcribing place names and names of people 100% correctly:
If a given name is found already transliterated in a text “incorrectly” such as Sharafaddin where it should be Sharaf al-Dæn, this is usually not corrected. Famous place names in Yemen often have numerous spellings in English. In such cases the most used, though closest to correctness will be used; Sana’a not Sanaa or Çanôæé. However this does not pose a problem until a little known name that was wrongly transcribed have to be translated back into Arabic. One informant wrote to me the name Bayt Gud for what should have been Bayt Qaôad. In such cases it would be hard to find the village on the map even though the survey authorities issue maps in both Arabic and English. On the other side, as there is such a forest of transliteration standards in the first place, one does need a little bit of fantasy and creativity dealing with the real world anyway.

4.3 Tools in the field: The water landscape approach

When I use the term the *water landscape*, I do not only imply natural water visible in the landscape but also human made water structures presently functioning or not, wet or dry.

The way I imagine the water landscape is a kind of GIS-brainwork, where I first look out on observable "layers" on an empty map as topography, hydrology, geology, geography, demography, and so on (ethnography, history, archaeology etc.). Then, I turn to observe water and water structures and imagine these as a separate layers merging on top of each other. An expert in system dynamics would probably also put on figures of quantity and quality of water flows etc, and an anthropologist could follow the water as it is fetched at the spring and brought into the household, observe and analyse how it is consumed or used, and perhaps ends up as wastewater. Eventually, the doctor in medicine would explain how this wastewater is a biological hazard for the village population and the meteorologist would easily imagine how the water evaporates into the air to finally come back as rain in the rainy season.

Of course, a Norwegian graduate student in water management in rural Yemen will the first times, only observe a couple of cisterns and a girl pulling up water filling it into "jerry-cans" next to a donkey. But, using senses and common sense and imaging the presence of "water" in the landscape in front of you is a good starting point. The idea is not to understand all the other connections at once, but having a "tool" that can organise all the overwhelming potential relevant information related to water in a landscape. It is a way to understand what is going on both physically and socially without having to leave the "objective" reality around you. When doing fieldwork in a very different environment and culture this is an important point.

If measured in minutes of the entire year, rainfall in the field area is a rare event. However, the rain often falls during severe thunderstorms and the landscape gets a completely different character. It is like a different scenario: Water is flowing everywhere. Numerous streams appear and completely dry wadis become transformed into fast flowing rivers. Since most of the time in the field is spent when the landscape is dry, one needs to add an imaginary layer of rain onto it to "see" water structures. The locals can easily see it with all their local

knowledge. Small traces reveal where the water reached last flood and lines in the landscape following the contours are usually collection canals that lay ready and only need to be cleaned before next rain. There is water moving through the dry landscape as well, but to fully understand the cultural landscape with all its water structures one has to take into account the scenario two; heavy rainfall.

The water trucks

This perspective has for instance made me see the role of the very important trucks that carry much of the water in the field area and the pumps and hoses that I also had not "expected" before I entered the field. It was the fact that they were immediately connected to- and containing- water that led me onto the trail. This might sound obvious, but actually the water trucks took a long time for me to "discover" as it was not pointed out by other scholars before in texts as important in Yemeni water management. They were certainly not "indigenous" or what I thought of as "local knowledge" before going to field. I think I observed them for a long time, but being prejudiced that they were not an "authentic" part of the water management that I wanted to study. The water landscape approach has since been an important way to realize what is going on in the water landscape, by following the physical water itself, and from there, branching off to other values and meanings.

As my first period in field went on, I realized that water brought in by trucks is a very important part of local water supply in addition to on- site rainwater harvesting. This topic is a very good example of the importance of qualitative method, especially in topics and systems earlier not much described. In the beginning I subconsciously decided not to look at the water trucks in field, probably because they represented for me something "globalized" and not "local". They did not qualify as data in my meta-narrative of what local traditional water supply was. I was open for looking into the use of new materials and techniques such as cement and PVC-pipes, but strangely enough, I was not prepared for including the water trucks. I knew about their importance in the supply system in the capital, but I had hardly seen them mentioned in any literature before going into field. They are only very vaguely mentioned in some development reports.

One can regard the Barthian model in fig. 1 as a kind of “corrective” model that helps posing relevant questions. It reminds the researcher of that any eco-technical aspects should be investigated. It is perhaps the issue of historical continuity and change, or diachronic comparison that really highlighted the water trucks together with the Barthian model.

4.4 Taking photos

Taking photos was an important tool during the fieldwork. The reason is that I managed to capture a set of related details, a landscape or water system, both for my own "note taking" and field documentation, but also to use as empirical data. Pictures can be used as a starting point for explaining an abstract and otherwise complex phenomena. It is a way of recording and presenting physical water structures and landscapes, but also of representing objects carrying important knowledge and cultural values.

There are many ways of using photography and advantages are only limited by creativity. Sometimes the most interesting shots were taken when the informants themselves were behind the camera. These pictures are very valuable when understanding my own cultural bias and perception of how a picture can capture the world in a "correct" way.

However, in the field, I felt a strong sense of self limitation and even self censorship when it came to freely capturing images of anything interesting to me. The many challenges I met when using the camera can be an example for other similar fieldwork challenges, such as note taking or the use of tape recorder.

My camera is expensive compared to local salaries and people always asked how much it cost. I felt it would be difficult to give the correct answer and often, I just smiled and said it was a gift. In my interpretation, the camera was a symbol of my strong economical situation compared to theirs. It represented far more than a yearly income for most people and "flashing" it after a good conversation about a small development project they plan to undertake, if they could raise the money, felt very bad. Your feelings do matter very much in how to communicate with people in the field. I often felt like people would think that the camera is a symbol of a tourist or development expert.

“Capturing” someone else’s property

The issue of photographing women is simple. No photos of women. Exceptions are general photos where women are located far away as an inevitable part of the picture. Although women in the villages are generally not so strict with using a veil, they often start packing the clothes and run away when if they are being photographed from a distance when washing clothes by the spring or a cistern. Only one picture of women fetching water was taken. It was spontaneously arranged by a local person with high authority. He would arrange it “so that people in my country could see their problems of water and poverty”. The prohibition of taking pictures of women is just an indication of a wider weakness of the whole research process concerning gender perspectives. I had no opportunity to have female informants, perhaps except for some older women in the countryside. The only way to get an impression about gender issues has been through anthropological literature, “westernised” Yemeni women experts, and foreign female development experts. Of course, Yemeni men do give a differentiated picture of the women’s perspective as well, and if this had been followed systematically from the beginning of the research process, a better understanding could have been reached. The whole topic did just not seem approachable from day one.

Care had to be taken not to be considered as someone who showed too much interest in military and governmental places and buildings. The society is by far more militarised than ours and there are usually no signs for buildings or places one shouldn’t photograph. Suspicion about someone that could potentially photograph something revealing is apparent. No one wants to be responsible toward their superior for letting someone know something they shouldn’t have. It might sound trivial, but it did put much constraint on the wider research process. The topic stated in research permit I got from the Yemeni Centre for Studies and Research was specific: “Systems of irrigation in Hajja”. Therefore, I also felt strongly to show that I respected the liberty given to me.

Fig. 41 Women fetching water. The picture of women was “arranged” by a local authority person. His influential family had just facilitated the pumping of water from a spring far away to this cistern, as many of the other water sources in the area had started to dry up. Caring for the weak is considered both a virtue but also a necessity to stay in power. The typical plastic containers taking 20 litres are called “dabba”. A woman usually carries one on her head and a donkey carries an additional 2 dabbas.

It was often expected of me to take pictures of the cisterns, as many informants thought I was a development expert and hence they expected me to behave as one. Former visits in the past to many of these areas were done by “experts” registering the number and location of cisterns and also photographing them. But if I started to photograph houses, roads or small irrigation canals, people started to look a little bit strange at me, and when I want to photograph people, i.e. men and children, they suddenly felt themselves in a “formal setting” letting their skirt down, looking proud and serious. Often, people asked if I could photograph them. Sometimes this was obviously the funny and special point of that day or week, and often joking and laughing occur among them. When I pretended as taking pictures of the cisterns was usually the time I used the camera for other purposes as well and not many pictures was taken outside this “activity frame”, simply because the negative connotations connected to use of the camera.

However, the most interesting pictures of daily life became impossible to take. It felt completely wrong to interrupt for instance the fast and speechless meal by "asking" people to stop eating and take formal posing positions. It would not be possible to say "don't care about the camera, just pretend it is not there, just do what you are used to". Cameras are not common and pictures are obviously only taken during formal occasions and hence expected to be a formal occasion.

I felt I could break this expectation as a photographer only partially connected to certain occasions, such as car driving, agricultural activities, but not meals for instance. It would probably make a difference if my role started to get more "known" in the local community and the limits for what is "correct use of the camera" was gradually formed by my self, and if I felt assured that these borders were becoming accepted. But for instance, capturing their poverty and misery always felt wrong. Many of these limits are my own personal perceptions of what would be correct behaviour and my strong need to feel respected and show respect in such a "foreign" setting probably made me more shy and careful than if I felt more at ease with the culture. On the other hand, I would have strong feelings of shyness, and even shame, if I was to take pictures from my neighbours' private life in my own country without having a "culturally legitimate" reason. My own personal shyness and protecting the feelings of the informants had to be balanced against the need for good data. To evaluate each situation was difficult, as I often had to interpret the feelings of the informants and mistakes were certainly done. One learns with increasing experience and interaction with the informants.

There are many things that made me feel not Yemeni, and drawing unnecessary and disturbing attention by using the camera is certainly one of them.

In general, being a researcher in the field is dependent on the relation between one's own self-confidence and one's ascribed status and feelings certainly matter.

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Endnote cannot reproduce the emphatic dot in the transliterated sources.

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